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The Use of Data Visualisation in English Local Authorities

A. Jenson

PhD

2018

The Use of Data Visualisation in English Local Authorities

Adam Jenson

A thesis submitted in partial fulfilment
of the requirements of the
University of Northumbria at Newcastle for
the degree of
Doctor of Philosophy

Research undertaken in the
Department of Geography
Faculty of Engineering and Environment

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Abstract

In recent years, there has been an explosion in the amount of data we have at our disposal. Data is big, open-source and transparent. As such, there is a renewed faith in data-driven decision-making. However, this also comes with its own caveats; the power of data is based on an assumed objectivity, of presenting a view from nowhere. These assumptions of objectivity, and the vast increase in the amount of data, have left problems in interpreting it. Organisations trying to make sense of data include local authorities, who are facing challenging times through enforced austerity spending measures, which have seen budget cuts, service restrictions and reduced staff numbers. They are told to become more efficient and targeted in their working practices, and this has seen a move in some organisations towards a data-driven approach. One proposed solution to this has come through data visualisation, which seeks to make sense of data, either through an ability to analyse previously unmanageable data sets, or through the communication of findings to a wider audience. It is this context from which this thesis draws its empirical focus.

This thesis contributes to methodological discourse in investigating data visualisation from a qualitative perspective. It investigates the wide range of networks, actors and intermediaries within the context of four specific local authority case study organisations in England. It makes a telling contribution to address the lacuna in the theory of data visualisation by applying a post-representational approach adopted from cartography, which seeks to build upon, rather than replace, the growing literature on data visualisation. A post-representational approach recasts data visualisation as a broad set of practices, to think critically about the practices of visualisation and not simply focus on the product. As such, it creates a theoretical space for future investigation, which incorporates both those seeking applied knowledge (asking technical questions) and those asking theoretical questions. Understanding data visualisations as processes reveals that they are not practiced in isolation; they are mobilised in relation to other tasks and are subject to the complexities, interactions, constraints and emotions of that moment. Unpicking these conditions, as well as the aesthetic and technical elements of production, provides a holistic interpretation of how data visualisations are brought into being and made to do work in the world, whilst contributing to the larger field of post-representational cartography by moving beyond maps and exploring the implications and differences in engagement between maps and data visualisations.

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Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the University Ethics on 18/12/14.

I declare that the word count of this thesis is 71,297 words.

Name: Adam Jenson

Signature:

Date: 28/09/2018

Chapter 1: Introduction

1.1 Introduction

In recent years, there has been an explosion in the amount of data we have at our disposal. Data are big, open-source and come with a plethora of publicised benefits, streamlining services and creating smarter decision-making. As such, there is a renewed faith in data in decision-making. However, this also comes with its own caveats; it often works through an assumed objectivity, of presenting a god-like view from nowhere (Aiello, 2009). Gitelman and Jackson (2013) suggest that data should not be considered as objective, raw and coming from nowhere, but instead as the answer to a specific question given in a particular context. As such, they are not universal truths which can be mobilised to answer any given hypothesis. These assumptions of objectivity, and the vast increase in amounts of data, have left problems in interpreting it. Some of the organisations trying to make sense of data are local authorities, who themselves are facing challenging times, with continued budget reductions applied through the context of austerity, and they have seen budgets, staff numbers and services greatly reduced. They are being asked to do more with less. They are told to become more efficient and targeted in their working practices, and this has seen a move in some organisations towards a data-driven approach. One proposed solution to this has come through data visualisation, which seeks to make sense of data, either through an ability to analyse previously unmanageable data sets or through communicating findings to a wider audience. It is from this context that this thesis draws its empirical focus.

Data visualisation as a discipline has a long history, with notable works such as Jon Snow's mapping of London's cholera outbreak (1854) and Florence Nightingale's Coxcombs (1859) illustrating its lineage and the practicality of communicating complex information throughout the ages. However, despite its roots, development of the subject has remained sparse and disjointed, lacking the rich depth of history of its neighbouring disciplines, such as cartography. The field of data visualisation is mostly approached from two key perspectives. First, data visualisation practitioners who work within the conventions of design (Kennedy, 2017) and best practice (Kirk, 2017), given their focus outside of academia, remain unconcerned with theoretical developments within the field. The second key approach is that of the scientific objective communication perspective (Few, 2004), which operates through a fixed ontology of scientific truth. Therefore, there has been little progress towards a critical, theoretical perspective on the field of data visualisation. To those key groups a data visualisation is a data visualisation: never in the state of becoming, it is ontologically fixed and it will always remain a data visualisation. The aim of this thesis is to begin to address this lacuna.

Given data visualisation's growing prominence in decision-making and service delivery for local authorities and other governance organisations, and its wider appeal in fields such as journalism, its lack of a theoretical grounding needs to be addressed. Local authority budgets amount to billions of pounds each year, and the basis upon which spending decisions are being made needs to be understood. Without adequate theory, understanding the role of data visualisations is crucial in this process. This thesis makes an early theoretical contribution towards understanding the (re)production of data visualisation within English local authorities. It does so by considering neighbouring subjects whose theory could be adopted and applied. Cartography is a more mature discipline which has developed through theoretical and philosophical engagements which, to date, have been neglected in the field of data visualisation. Cartography has a rich history in academia, and it is upon this that this thesis draws. Particular attention is drawn to the multiple similarities in these two fields' evolution and potentially overlapping theoretical developments. For example, early work in cartography was focussed on models of communication (Morrison, 1976) and functionality (Robinson, 1976), which can be compared to the contemporary field of data visualisation. Since the 1970s, however, the critical turn in cartography has provided tools for deconstructing maps in order to reveal the hidden power dynamics (Harley, 1989). By deconstructing maps, scholars were able to build a new theoretical foundation for cartography, which placed each map in its own historical and social context and reflected the ideals of those who created it. More recently, a small group of scholars have sought to challenge the ontological security of maps, moving from a representative to a processual approach (Del Casino and Hannah, 2000; Kitchin and Dodge, 2007; Kitchin et al, 2012), considering maps as ontogenetic – of the moment, constantly in a state of 'becoming', and made to do work in the world (Kitchin, 2007). I argue that the critical theories of cartography, and post-representational approaches in particular, provide the basis for a common framework both for those seeking applied knowledge (asking technical questions) and those who seek to ask theoretical questions (Kitchin, 2012).

The main aims of this research, then, are to examine the role of data visualisation within local authorities in England, and it does so by initial exploration through a broad scoping questionnaire, before investigating four case study organisations. In order to fill the gap in the literature regarding a lack of theoretical engagement with data visualisation, this research adopts the work of Kitchin and others (Kitchin and Dodge, 2007; Kitchin et al, 2012) to apply a post-representational cartographic lens to local authority data visualisation. I investigate how they 'become' through a five-part framework that seeks to understand the *aesthetic*, *technical*, *social*, *political* and *embodied* dimensions of the (re)production of data visualisations. The research questions for this study are:

1. *How and why do local authorities use data visualisation?*
2. *How do visualisations 'become'?*
3. *How useful is post-representational cartography to understanding data visualisation?*

Although this research could be presented through many lenses, it chooses to use the organisations of local authorities from which to contextualise and apply a post-representational cartographic approach to data visualisation. Although it illuminates the key examples of the types of issues facing authorities and staff who engage operationally with data visualisation, it is not presenting a case of particular practices, but is a discussion of the potential benefits of considering data visualisation as 'ontogenetic'. In recognising that these processes are (re)made individually, this research does not aim to present a report on best practice; it seeks to present a theoretical discussion around considering data visualisation from a post-representational cartographic perspective. In pinning down complex unfolding practices, it recognises that data visualisations do not emerge in the same way to each individual and, as such, transpire as being filtered through a complex network of social, technical, aesthetic, embodied and political processes. Considering data visualisation in this way renegotiates the role of the audience in authoring their own meaning into texts, the role of the momentary context of engagement and the influence of the multiple competing processes which shape engagement.

In order to fully investigate the effects of these processes on the individual and to encourage openness with participants with regards to their working environments and the operational constraints in engaging with data visualisation in local authorities, it is necessary to anonymise participants and organisations.

In answering these research questions, this thesis contributes to a methodological discourse in investigating data visualisation from a qualitative perspective. In keeping with the work of Couldry and Powell (2014), as previously highlighted, there has been a lack of attention in research to the social actors and groups of actors, in a variety of places and settings, which influence data visualisation production. Similarly, Ambrosio (2015) suggests that in order to fully understand the production of data visualisations, we should consider them as a series of choices made by actors and intermediaries. More recently, Kennedy (2017) suggests that the role of actors and intermediaries are themselves influenced by the decisions and priorities of the organisations which created them. This thesis therefore presents an initial attempt towards exploring these challenges by investigating the wide range of networks, actors and intermediaries within the context of a specific organisation. In addition, this thesis contributes more broadly to the field of post-representational cartography by providing an early attempt to answer Kitchin's (2007) call to untangle the unfolding practice of data visualisation. This is done by exploring the constellation of actors and their interactions that shape the unfolding, which includes knowledges

(existing manuals and guides), practices (aesthetic choices, conventions), immaterialities (equipment, software) and the organisations themselves.

This research helps to address the lacuna in theory in data visualisation by applying the post-representational approach, which seeks to build on, rather than replace, the growing literature on data visualisation, and does not exclude the bodies of work from the adjoining disciplines. Rather it presents a point of focus which encompasses the previously established work, and offers enough flexibility to encourage further development from fields not mentioned within this research. A post-representational approach recasts data visualisation as a broad set of practices, to think critically about the practices of visualisation and not simply to focus on the product. In doing so, it creates a theoretical space which incorporates both those seeking applied knowledge (asking technical questions) and those asking the theoretical questions. This research therefore presents a case for shifting the ontological position of data visualisations and considering them as processes, not as representations. This reveals that they are not practiced in isolation; they are mobilised in relation to other tasks and are subject to the complexities, interactions, constraints and emotions of that moment. Unpicking these conditions, as well as the aesthetic and technical elements of production, is key to providing a holistic interpretation of how data visualisations are actioned into being and made to do work in the world. This research also highlights the difference in the temporalities of engagement with maps and data visualisations. In everyday use, maps are enacted to solve relational problems such as how to get from A to B; they are usually actioned out of necessity (Del Casino and Hannah, 2000; Kitchin and Dodge, 2007). The map is enacted for as long as is needed in order to get to one's destination. Similarly, data visualisation is undertaken to provide insight or to communicate analysis into a particular issue. In order to maximise interpretation, users must be receptive, curious about the subject and willing to invest time in interpreting its knowledge. A further difference is revealed when considering the difference in the temporality of 'becoming' for maps and data visualisations. The phenomena on show on maps do not change so readily: roads, mountains and cities are less likely to change in a drastic manner in the short term. However, local authority data visualisations are often designed for a specific time span: for instance, communicating results for a weekly, monthly or quarterly period. In the short term, the data changes, which often means illustrating an entirely new set of results.

This research has also adopted the work of Pickles (2004) and proposes that data visualisations should be considered not as readerly texts (those that create readers for an already written text), but as writerly ones (those which require the reader to, in part, author meaning). Interpreting data visualisation in this way places recognition on the labour which is, in part, undertaken by the audience to gain insight, clarity and depth in interpretation. In applying Pickles' (2004) conceptualisation, data visualisations as writerly

texts provide a multiple and open series of readings. This means that the success of a data visualisation in relaying its message is not an inevitable consequence of the design practice. The ability of the audience to interpret the information is not something which is rigid and can always be ‘designed in’. It is a more fluid exchange between designer and audience, and the result of existing knowledge, skills and an audience’s willingness to engage.

1.2 Overview of chapters

Chapter 2 discusses the three main fields of study which are significant to data visualisation and this particular research. It contextualises the study by firstly addressing the vast increase in data and introducing critiques, assumptions and theoretical approaches to data. It then considers the field of data visualisation and begins by depicting its history and notable works. This illustrates that data visualisation, despite its recent surge in popularity, is not entirely a modern phenomenon. Following this, a cross-examination of key work in the field of data visualisation production is discussed to highlight the pathways of production and the role of ‘chart selection’ in framing the insight and analysis on display. It then explores critical approaches to data visualisation, and highlights the disjointed body of theoretical work. This critical approach also draws attention to the role of actors, intermediaries and organisations in production, which influence the analysis chapter of this research. The final section of Chapter 2 provides an account of critical work in cartography. Initially it explores early communicative and representation-based models to highlight its similarity to current data visualisation. It then explores the theoretical developments of cartography as the focus shifted towards a more critical and politically focussed field. This work offers potential avenues for exploration, which can advance our understanding of the work data visualisations do in the world. The final section addresses the most recent shift in cartographic thinking: a post-representational cartography that moves from a representational to a processual approach, and outlines the framework which is enacted to reveal the findings within this thesis.

In Chapter 3, I utilise the literature which was outlined in the previous chapter to evolve my research questions. Here I begin with the theoretical underpinnings of my chosen mixed methods approach. My case study selection and justification is also made in this chapter. Once complete, I reflect on the process of research and the methods I adopted. The chapter concludes with some personal reflections on the fieldwork process.

With my conceptual and methodological framework established in Chapter 4, I present the first of my empirical chapters. It begins by providing an account of the broad scoping survey, firstly illustrating differences between local authorities, and secondly providing an insight into the three key pathways of the production of data visualisation as identified from the survey results. The first two identified staff as being solely responsible for the initiation or application of data visualisation, or the organisations as having no uniform data visualisation strategy. A smaller number of respondents highlighted their organisations as having access to a specialist designer or design team. It then explored the software and skills involved in the pathways of data visualisation production within English local authorities. With this established, I then present an in-depth account of each of the four selected case study organisations: Authority 1, Authority 2, Authority 3 and Authority 4. In presenting each of the organisations, I illustrate their differences in structure, services, demography and the effects of austerity. In the second half of each case study, I address their particular engagement with data visualisation to highlight their networks of production, the skills and backgrounds of their actors and the roles involved in producing data visualisation. The final section of this chapter brings together an account of the processes of production which are unfurling across all the case study organisations. I illustrate the economic and organisational drivers that provoke engagement with data visualisation, the sources of data, the requisite skills and training and the common constraints.

Once this is established, Chapter 5 turns its attention to the second and third research questions. It draws together evidence across the four case study organisations to apply the chosen theoretical framework adopted by Kitchin (2012) to investigate how data visualisations ‘become’ by applying a post-representational cartographic approach to data visualisation. In order to best structure and unpick the multiple competing and complex processes which emerge as data visualisations unfold, the five key processes are presented individually. The *aesthetic* presents the design conventions in presenting a professional standard for data visualisation creation. It gives an account of their role in providing the opening exchanges in the emergent practices of data visualisation. The *technical* illustrates the role of technical skills and data literacy in the unfolding practice of data visualisations. Within local authorities, complexity was reined in and limited to its most simple. Unlike maps, which can be used to solve relational problems, data visualisations are often enacted voluntarily. There are also further technical challenges which constrain the emergent practices; this section therefore addresses issues of technology and connectivity in relation to wider critiques of the digital divide. The third process discussed is the *social*. Here I depict data visualisation as unfolding through a collaborative function between user and narrator, through conversation, through the actions of pointing, probing and tracing lines. The performance of a data visualisation begins to enable a more social, experiential unfolding. The fourth process discussed is the *political*. In this I illustrate the role of the designer in manipulating the message of the visualisation and the role of the organisation in influencing information. The fifth framework is

the *embodied*. In this section, I draw on the work of D'Ignazio (2015) and explore the beauty, complexity and creating an emotional bond in attracting the gaze of the reader. The final section of this chapter draws on the findings from Chapters 4 and 5 and answers the third research question by reflecting on the potential and value of a post-representational cartography as applied to data visualisation.

Chapter 6 brings together my findings and outlines my empirical, methodological and theoretical contributions made in relation to the wider academic fields of data visualisation and post-representational cartography. Finally, I highlight the three proposed avenues for future research, which build on this research and more broadly the field of data visualisation.

Chapter 2: Literature Review

2.1 Introduction

The following chapter presents the theoretical grounding for the methodological intervention into this research. It aims to present work in the field of data visualisation and to highlight its focus on the practical application of the discipline. It does so to bring a familiarity to those practices and to the influence of particular authors who shape data visualisation design in local authorities. It then draws attention to the interdisciplinary nature of the field and the way in which other subjects have been adopted and mobilised to provide insights within the burgeoning field of critical data visualisation. The disjointed and sporadic nature of this field also illustrates the need for a more holistic theoretical interpretation, to better understand the way in which it works in the everyday – something which is addressed in this research through the application of a post-representational cartographic framework to local authority data visualisation, which is discussed further in Chapter 5.

Having discussed the field of data visualisation, the second half of this literature review focusses on the field of cartography. It does so to highlight the similarities between these two subject areas, and draws comparisons between previous paradigms in cartography and contemporary data visualisation studies. Cartography has a long and rich history of interpreting spatial data graphically and visually. It has its early works rooted in communication and perception, which are still influential in key principles of data visualisation. A chronological account of cartography is then traced to reveal the potential avenues of exploration for future data visualisation research. Cartography has a history of being considered as an objective reflection of the world. However, over time it has been shown as being inscribed by the aims, ideals and dominant groups who create it (Harley, 1989). Maps have also been shown to have been mobilised for more devious means (Pickles, 2004) and used as political tools due to their ability to hide behind scientific objectivity, create knowledge and present truths (Crampton, 2006; Goodchild, 2007). By presenting these works, it embraces the rich history of cartography and shows how current theoretical advances in cartography can be applied to data visualisation to present a cohesive and grounded academic field. It is important to become familiar with aspects of the field of critical data studies. Data provides the foundation of visualisations, yet can still be considered as objective, neutral and raw (Gitelman and Jackson, 2013). Therefore section 2.2 provides an introduction to critiques, assumptions and theoretical approaches to data, as well as methodological problems in understanding and interpreting data, before addressing visualisation as one potential solution to those challenges.

Section 2.3 explores data visualisation. It begins by depicting its history and notable works, to illustrate that data visualisation, despite its recent surge in popularity, is not entirely a modern phenomenon. Following this, a cross-examination of key texts in the field of data visualisation production is discussed, to create familiarity with the pathways of production and the role of ‘chart selection’ in framing the insight and analysis on display. This section then explores more recent critical approaches to data visualisation, and highlights the disjointed body of theoretical work. The critical approach also draws attention to the role of intermediaries and organisations in production, which influences the analysis chapter of this research. The final section of this chapter (2.4) focusses on a chronological account of cartography. Initially it explores early communicative and representation-based models to highlight their similarity to current data visualisation. It then depicts the theoretical developments of cartography as focus shifted towards a more critical and politically focussed field. This is discussed as it offers potential avenues for exploration which would advance our understanding of the work data visualisations do in the world. The final section addresses the most recent shift in cartographic thinking. A post-representational cartography moves from a representational to a processual science (Kitchin, 2007). It draws attention to the notable works and the benefits of advancing the field. This section mobilises the work of Kitchin (2012) as the framework which is mobilised in analysis in this thesis to explore what can be learned from applying a post-representational cartographic lens to data visualisation.

2.2 Austerity

Austerity in Britain arrived as a result of the global financial crisis and the stress it placed on the economy. The massive austerity measures, which began to be imposed in 2010 by the Conservative-led coalition government, have had a devastating impact on the everyday lives of citizens (Ballas, Dorling and Hennig, 2017). The response to the global financial crash was processed through the ideology and manifesto of the conservative political regime and has seen enormous cuts to public services, and national and local government budgets, as a way to enable the United Kingdom to begin to ‘live within its means’ (Loopstra, 2015). Austerity saw a tightening of purse strings that continued to grow in severity in the following decade. Local authorities and the services they deliver have been one of the most impacted groups from almost a decade of austerity spending measures. They have continued to see reductions in budgets, staff size and the availability of services they offer (Ferry, Coombs and Eckersley, 2017). It is for these reasons that local authorities are now forced to seek alternative means of delivery. They are faced with adapting their approach or experiencing the very real threat of permanent removal of certain services. It is within this context and these challenges that data and data visualisation have come to the fore as a means of doing more with less, allowing local authorities to

become more targeted, efficient and innovative in their delivery of services (discussed post-representationally in Chapter 5).

One enabling factor in the deep-rooted affliction of austerity was that the introduction and continued severity of cuts met little challenge in national politics and the media (Bambra and Garthwaite, 2014), and austerity has been critiqued by Klein (2007) as being a tool made for political ends. Rather than being a measured response to the economic crisis, austerity has become an excuse for further appropriation of social resources by the rich (Klein, 2007). Austerity spending measures have also been criticised as being unnecessary, and the language of austerity merely constitutes for further concentration of power and wealth in a few private hands; it has been considered as the main justifying mantra for the coalition government's economic and social policy (Levitan, 2012).

The global financial crash and the justification of austerity provided an opportunity to force down public sector spending, which manifested itself as cuts in welfare, which impinged on the sick, young, poor and disabled. In 2015, local government spending was described as having fallen by a third since 2008 (Bambra and Garthwaite, 2015), although, as presented through the case studies below, this figure has continued to grow and local authorities are still challenged with enforced spending measures which place many services under the very real risk of being switched off permanently. Bulman (2018) notes that 2019/2020 marks the biggest cuts to government funding since 2010 in the face of unprecedented pressure and demand on services, and a further £1.3 billion reduction in funding from central government has left 168 councils without a revenue support grant (Burns, 2018). The rising pressure on individual councils has increased speculation that more local authorities could follow Northamptonshire County Council into bankruptcy (Butler, 2018). The scale and impact of cuts is further illustrated by the loss of funding by as much as 60p of every £1 the government had provided for services between 2010 and 2020. Further projections suggest an £8 billion funding hole by 2023 unless there is a change in action towards the demand and costs for adults' and children's care services (Burns, 2018). The pressure for adults' and children's services means councils are being challenged to find financing from other departments, meaning many will lose the ability to provide anything more than their statutory responsibilities (Burns, 2018), whilst others will have to sacrifice more popular services such as parks and leisure, libraries and Sure Start centres.

The full impact of austerity is also felt in the everyday lives of people, through cuts to both central and local government budgets. The growing social divisions following austerity spending measures since 2010 have had a devastating effect on the most disadvantaged (Ballas, Dorling and Hennig, 2017).

Burns (2018) suggests that local authorities are increasingly unable to provide dignified care for the elderly, whilst Bulman (2018) suggests that the elderly, children and the homeless are being left to fend for themselves. This is evidenced by reductions in spending on children who are at risk of neglect or abuse, which has been slashed by 26% over the past five years, whilst overall spending on children's services has dropped by 42% (Bulman, 2018). The cuts to local services have also compounded and have in some cases excelled the growing spatial and health inequalities nationally (Bambra and Garthwaite, 2015). These growing chronic spatial inequalities are disproportionately affecting the older industrial areas in the North (Beatty and Fothergill, 2014). Bambra and Garthwaite (2015), for example, identified that real-term spending per working age adult had reduced by £470 in Middlesbrough, compared to only £50 in Hampshire. This has deepened societal problems, with many parts of the country facing issues of social depreciation. Austerity has led to a rapid worsening of overall UK health (Dorling, 2016). There has been a growing reliance on food banks, an explosion in the number of children in care and over 80,000 families placed in temporary accommodation (Butler, 2018).

At the same time as these cuts, central government is embarking on a process it calls 'localism', which in short refers to the transfer of power, authority and resources from central government to local government and public organisations. The following sections draw attention to localism and its role in setting the context for this research. Localism is itself a fuzzy concept with many uses and meanings (Clarke 2013). Firstly, it can be used to describe the positive disposition towards the decentralisation of political power due to its connections with democracy and community. Secondly, it is used to describe the decentralisation of political power to elected local government and local bodies (Lowndes and Pratchett, 2011). Clarke (2013) described the use of localism in political discourse as being purposefully vague in meaning and imprecise. It brings together political notions of decentralisation, participation and community, geographical understandings of scale and place, as well as managerialist interpretations of efficiency (Clarke, 2013).

There has always been a 'localist' element to British politics (Clarke, 2013). However, this research mobilises localism as it (re)emerged as a defining political keyword against a backdrop of austerity spending measures and endorsed by the 2010 coalition government (Featherstone et al, 2012). The 2011 Localism Act fundamentally altered a key component in local integrity and governance (Lawton and Macaulay, 2013). It foregrounded a particular form of localism and was considered the most wide-ranging legislation on English local government in several decades (Lawton and Macaulay, 2013), and it has been described as 'a radical devolution of power to local level' (Communities and Local Government Committee, 2011). Key elements of the Localism Act include new community rights to bid for land, new neighbourhood planning rights, the transfer of public functions to local authorities in order to improve accountability or promote economic growth and the creation of general powers for

local authorities to develop innovative approaches to service delivery and governance (Lawton and Macaulay, 2013). Localism from the coalition government involved at least three parts. The first was to remove the central and regional control on local government, the second was to make local governments more accountable, and the final point was to devolve power beyond local government to local groups and organisations (Clarke, 2013). Although the coalition government's approach to localism diverges significantly from that of New Labour, it does pick up on some of the legacies of previous governments, such as engaging civil society as a partner in wellbeing (Lowndes and Pratchett, 2011).

Localism is perceived as being beneficial to local governments as they are comparably less bureaucratic than their regional or national counterparts. This in turn reduces the amount of money being spent on bureaucracy and increases the ability to spend on the front line (Clarke, 2013). This has broader benefits for local communities, as governance becomes more efficient, more democratic and more responsive to the needs of the communities (Lowndes and Sullivan, 2008). Localism is said to provide greater accountability and a sense of engagement with local issues. Centralisation can create distance in our democracy between the government and the governed (Clarke, 2013). Therefore, through localism, it is assumed people can know local councillors or become local councillors themselves (Corry and Stoker, 2002). Blond (2010) describes localism in this way, considering civil society as a mediator, allowing for responsible action and positive welfare outcomes to be achieved. Furthermore, Clarke (2013) highlights that centralised national policies do not allow for local solutions to major social problems.

However, this has been critiqued, as localities are by no means natural, local needs are rarely homogenous, and effective solutions to local needs are rarely found just at the local scale (Smith, 2001; Amin, 2002). The localism of recent governments fails to recognise the transient and temporality geography of individuals who regularly move across local borders, whilst also failing to recognise the plurality and diversity of many localities, which incorporate a mix of genders, sexualities, social classes and ethnic backgrounds (Mohan and Stokke, 2010). This in turn can lead to conflicting and diverging interpretations of local needs (Featherstone et al, 2012). There are also critiques of localism as being part of a wider process of austerity spending measures in England. Featherstone et al (2012) note that this form of localism is not politically innocent and is part of a much broader practice, in which the central government has constructed the local as antagonistic to the state (Featherstone et al, 2012), with localism being employed to instigate a new 'roll back' of neoliberalism (Peck and Tickell, 2002), which involves dismantling and downsizing public organisations, privatising public services and attacking collective entitlements through funding cuts (Peck, 2010). This form of 'austerity localism' (Featherstone et al, 2012) is applied through the context of increasingly vicious spending cuts and can

be considered as a mechanism for the central government to externalise responsibility for the performance failure of local government (Lowndes and Pratchett, 2011). Furthermore, the impact of cuts and the wider costs of recession undermine the prospects of localism for all but the most affluent councils. This form of localism has also been critiqued due to its refusal to engage with power relations and inequalities within communities. Therefore, those who are likely to be empowered is not an equal process, but instead only engages with certain citizens – those with resources, expertise and the required social capital. As I draw upon in the empirical chapters of this thesis, austerity is not only the context from which data visualisation engagement is encouraged, but it is also identified as being important in understanding the social, political and technical unfolding practices of data visualisation in everyday practice. The following subsection explores the effects of austerity in the UK and offers some critiques of the politics of austerity.

2.3 Data

Data is becoming embedded within everyday technologies and everyday lives. As we move into the data-driven age, social scientists are beginning to understand and conceptualise data in new ways to provide theoretical understanding and burgeoning academic literature. Defining and understanding the context and changing ways in which data has become available can provide a great foundational framework to later understand the complex political economy entwined in the creation of data visualisation. This section presents the changes and increase in data and the challenges of understanding data. It does so to provide the context in which data visualisation has become one potential solution for meeting these challenges.

2.3.1 Big data

Where once sparse, costly data formed understandings of the world, there is now an abundance of data, which shapes the world and creates knowledge (Kitchin, 2013). Data is now embedded in everyday life, and commonly available technologies act as vessels to collect, store and link data. The Internet, computer software and social media have all contributed to an explosive growth in the amount of data which is generated. This, combined with technological advances and software roll-out, from which technologies have transformed from ‘dumb’ to ‘smart’, has meant that the early 2000s ushered in a transformation in the volume of data being generated and collected (Eaton et al, 2012), leading Google CEO Eric Schmidt (2010) to state that more data is being produced every two days than in the entire history prior to 2002 (Kitchin, 2014). This is expected to continue, and global data is expected to continue to grow by 40% per year (Manyika, 2011). The European Union Director for Digital Agenda suggests that 1.7 million billion bytes of data are generated per minute globally (Rial, 2013). The huge

increase in data has been termed ‘big data’, defined as data which is exhaustive, vast in volume and high in velocity (Kitchin, 2014). It is considered dynamic and varied in its ability to be utilised and connected in different ways, and its low cost means that it can be gathered prolifically. Kitchin (2014) suggests three sources for data collection, the first being directed data, which is most commonly associated with traditional forms of surveillance, such as passport control and CCTV. In these instances, a human operator controls the technological gaze.

Automated data is that which is inherent and automatic to the function of a device, and includes data from mobile phones, which create data and record their history simultaneously, producing records of how users navigate apps and revealing their clickstream data, which illustrates how people navigate the mobile web. Showing when and where it was requested and how it was used. Capture systems are those that record data from a task whilst it is being performed, such as store checkout systems. Also, the scanning of machine-readable objects such as travel passes which gather data about a person’s movement through a system (Kitchin and Dodge, 2011).

The final data type is volunteered data, which is gifted by the user. This is most commonly illustrated as interactions across social media, such as posting comments, as well as the crowd-sourcing of data, where data is generated by individual users and contribute to a much wider system of information, such as OpenStreetMap.

These changes and the burgeoning field of literature on big data have provided a variety of opportunities and challenges to make best use of the newfound field. Social science has historically created theories and shaped our understanding of the world utilising scarce data supplies and samples. Optimistically approaching big data allows an opportunity to develop a new era of conceptual social science based upon large data sets. In order to fully explore and analyse the newfound unstructured data, new tools to curate and manage data must be developed (Kitchin, 2013). This, however, does pose new challenges, as mentioned above. Academics traditionally look for relationships, concepts and theories within small sampled data sets. The transformation towards big data therefore poses a methodological problem. Kitchin (2013) notes that within the social sciences, methods appear ill equipped to deal with the transformation, and in order to fully realise the potential of big data, new tools must be realised. Kitchin also suggests that the era of big data could spell the end of theory, as there is no longer a need to develop trends as the ‘whole picture’ can be revealed (Kitchin, 2014b). However, there will always be a need for big data to contextualise a moment, which seems best suited to the intervention of social scientists. There is also a suggestion that big data holds superiority over previous small sampled work. This notion proposes that big data provides a full picture and a clear understanding, and that the complex relationships within are waiting to be revealed. This devaluing of small data studies neglects to realise

that, however exhaustive and large a data set is, ultimately it is still a sample (Kitchin, 2013). Taylor et al (2014) suggest that the scale of big data and the popular excitement surrounding it give the impression that the data is completely raw and comes from nowhere. However, it must be recognised that data does not exist independently of the ideas, techniques, technologies and context in which it was created. This is a point best summarised by Gitelman and Jackson (2013), who suggest that the very notion of raw data is an oxymoron, that data is never raw and always cooked.

2.3.2 Open data

Data has undergone great changes in recent years. The drastic surge in the amount of data being produced has led to new developments, concepts and an increased desire to understand data theory. Whilst big data is defined by its exhaustive size, open data is defined by its use (Gurin, 2014). Open data is data that is publicly available, which was once considered to be expensive and private. Shadbolt et al (2010) define open data as having two key characteristics: the first is that it is accessible to the public; the second is that it needs to be licensed for reuse, which truly democratises the information (Gurin, 2014). Its advocates often promote it as being more useful, more democratic and less threatening (Kitchin, 2014b). Open data is often promoted hand in hand with government transparency, which has gathered great momentum on both sides of the Atlantic in recent years. Transparency is often mooted as a tool which, when acted upon correctly, encourages greater accountability in public bodies, through citizen journalists and armchair investigators (Pollock, 2006). Public participation in these issues is intended to dramatically increase the accountability of public bodies, which will then improve governance. Shadbolt et al (2012) showed some scepticism by suggesting that it is only once participation is achieved on a great scale that the potential of open data can truly be realised.

Despite all of its promise, it is noted that open data has developed far faster than any critical understanding of the issue. Being thrust into the public eye on a wave of positivity has meant that, while data is becoming more open, we seem unaware of the long-term effects. One major area requiring attention is a long-term, sustainable financial model for open data (Kitchin, 2014). Whilst open data can be distributed for minimal cost, the initial collection, production, curation and management of data can prove extremely costly (Pollock, 2006), particularly when specialist equipment and skilled staff are required. It is already noted that even in the early stages of open data, austerity cuts have caused problems of fluctuating quality in data, which in turn reduces the response rate and almost nullifies the possibility of innovation (Kitchin, 2014) – an issue which is reintroduced in the context of local authority case studies (Chapter 4). Ossella (2013) suggests that one solution may be direct government subvention, the idea being that the release of data will lead to new, innovative products which can create new markets and increase the taxable income for the government (Pollock, 2006). However, Kitchin

(2014) disagrees with this premise and suggests that, whilst this may hold true in certain high-value data sets such as mapping and transport, it is less likely that other fields will develop new markets.

Open data has also been criticised for lacking usability (Pollock, 2006), with some open data websites said to resemble ‘data dumps’, which lack sufficient support tools to actively encourage participant analysis (Kitchin, 2014). Perhaps open data is a victim of its own popularity, with websites resembling rough-and-ready responses to emerging phenomena, produced in order to meet a specific demand at the time without much idea of ever achieving the overall intended aims. The theme of unmanageable data dumps is something which reoccurs during the case study exploration in Chapter 4.

One major flaw in the open data movement is that it ignores the politics of data. It is widely perceived as being democratised, and a tool for good and for equality. Whilst those efforts are commendable, they neglect questions about how the data is used, for whom the data is being released and in whose interests (Shah, 2013). As mentioned above, there are questions about the quality of data being released and a clear lack of usability. In these instances, the nobility of free data must be questioned as to how data that not everyone can understand can contribute to a free and equal understanding of issues. Even in cases where the usability is improved, there are still questions as to just who can make use of the data. Kitchin (2014b) states that it often falls upon the socially privileged, noting that the complexity of the hardware and software involved creates distance for the unskilled and untrained. Furthermore, even once the data has been analysed by citizen journalists, they lack the political skill or contacts to make their voices heard. Open data is underpinned by a political economy ideology, driven by multiple actors with their own agendas and aims. Bates (2013) suggests that the key participants are not the public, but big business and the government. Contextualised within austerity cuts and the privatisation of public services, the whole movement gained real momentum once big business began campaigning for open data (Kitchin, 2014), in which the dominant capitalist agenda worked under a cloak of transparency to meet their own needs. In doing so, they gained access to expensive public data for free. Bates (2013) also suggests that open data initiatives may be part of a deliberate strategy which opens up all public services to private competition.

2.3.3 Critical data

In recent years, the world around us has become increasingly data driven. As we move towards smart technologies, there is more data being produced and it is increasingly being mobilised to inform and shape how we receive and disseminate knowledge. At the same time, academics have been engaging critically with what this might mean. There is a renewed faith in numbers (Van Zoonen, 2014) and the

insights data delivers, which has led to a data delirium (Beer, 2016). The way data is embedded within our everyday lives also means it is being used to explain social phenomena. Mayer et al (2013) refer to the datafication of everyday life, as we project more of ourselves, our interactions and our relationships onto various social media platforms; this presents an opportunity for data to be mobilised to explain social relationships and everyday experiences. Because of this faith in data, Kennedy et al (2016) suggest that it is becoming increasingly valued, important and influential in decision-making and shaping our knowledge about the world. As such, it is important to begin to inspect the assumptions of data.

The field of critical data studies begins to challenge the objective assumptions of data. In their work, Gitelman and Jackson (2013) coin the term 'raw data' is an oxymoron, a point which is reaffirmed by Kitchin (2014b), who suggests that data should not be considered as objective and coming from nowhere, but instead as the answer to a specific question given in a particular context. Data are not universal truths which can be mobilised to answer any given hypothesis. Crawford (2013) describes the assumed scientific objectivity of data, which allows the researcher to present a view of a phenomenon from afar, meaning users can be removed from closer scrutiny, whilst the presentation of numbers minimises the need for intimate knowledge or personal trust. Kennedy et al (2016) further this by suggesting that data mobilised in media and other commentary often presents itself as speaking the language of facts, which in itself creates a level of assumed trust between object and user. There are also issues of access and language. Boyd and Crawford (2012) suggest that, despite notions of clarity and transparency, those unable to speak the language of data are excluded from the conversation, which reproduces existing uneven power relations, and new data-based ones emerge. This has led to new challenges in understanding data. Kennedy (2017) suggests that the proliferation, meaning and analysis of data open up further academic avenues of exploration and the possibility of new forms of discrimination, exclusion, privacy invasion, surveillance, control and exploitation. These issues of data numeracy, access and objectivity are all again readdressed within the analysis in Chapter 5.

2.4 Data visualisation

The importance of visualisation has increased dramatically in recent years. The availability of data has generated a need to find new ways to best utilise it and help maximise its potential (Kitchin, 2014). Visualisations have come to the fore as a means of tracing patterns, discovering new trends and ultimately revealing new phenomena (Leegwater, 2010). As such, visualisations are currently an

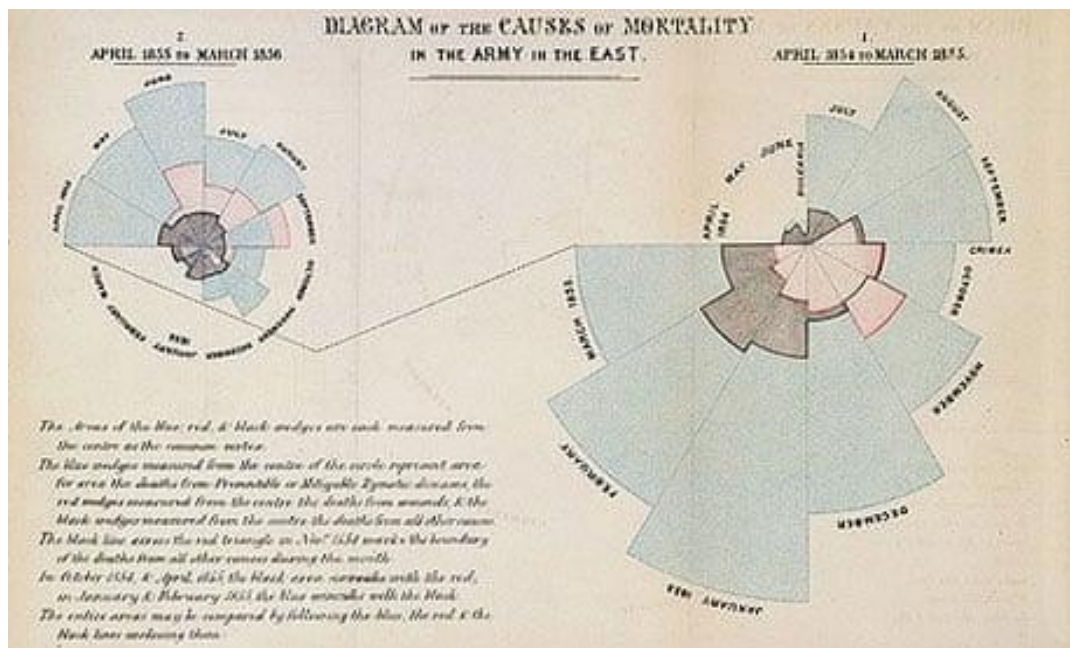
essential tool in the successful communication of such a data-induced world. Another justification of the current importance of visualisations is that they have ‘gone public’ (Fonseca, 2010). Data continue to be made public and are widely available through transparency agendas. This, combined with the availability of desktop software and web apps, is said to facilitate the investigation and sharing of insights.

2.4.1 History of data visualisation

This section draws attention to the history of data visualisation. It aims to show that data visualisation is a field with a long history, but the examples given also highlight how sporadic and somewhat sparse this history can be. This is important to consider against a subject such as cartography, whose history is equally long, but which has a much greater depth and body of work, both practically and theoretically.

It is important to highlight that, despite the contemporary field being somewhat burgeoning, data visualisation has been a prominent part of communication, investigation and analysis for a much longer period of time. The introduction of data graphics can be traced back to the work of Lambert and Playfair in the late 1700s, who first used visual interpretations of data to explore data and reveal patterns (Tufte, 1983; Tufte, 2001), although the 19th century produced a plethora of new and notable developments in maps and charts. Jon Snow’s (1854) significant work in analysing the cholera outbreak in London in 1854 is one of the key defining works in the field of visualisation. At the time, the cause of cholera was assumed to be the foul air. However, by mapping the local water pumps and the number of deaths due to cholera, Snow was able to trace the outbreak to a particular water pump located on Bond Street. The use of visualisation as a tool for communication led to that particular pump being shut down and a subsequent decline in cholera-related deaths. Despite being critiqued in later years for not assessing varying densities of populations in and around the water pumps (Tufte, 1983), Snow’s work is considered to be one of the key foundational pieces in the field of data visualisation (Rogers, 2013).

Figure 2.1. Florence Nightingale’s Coxcombs (Source: www.understandinguncertainty.org).



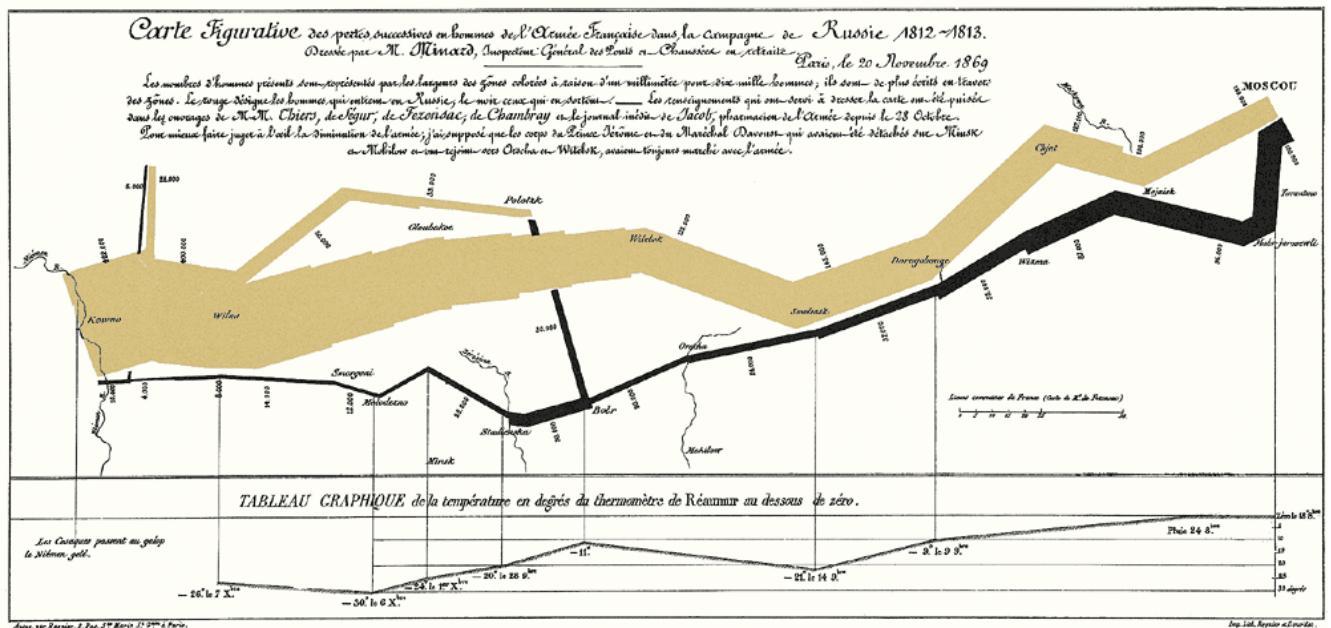
Following her predecessors, Florence Nightingale's notable visual documentation of the conditions for injured soldiers in Crimea (Nightingale, 1859) is largely interpreted as being one of the most defining works in the field of data visualisation. In this example, the mortality statistics of wounded soldiers were presented in 'coxcombs'. They depict cyclical data, including mortality statistics per month of the year. The shadings in each segment represent the cause of death, demonstrating that most soldiers were in fact dying from diseases caught in hospital rather than wounds inflicted during war. The visual presentation of the data meant that Nightingale's findings were able to reach a far broader audience.

Figure 2.2. Jon Snow's cholera outbreak map (Source: <https://www.theguardian.com/news/datablog/2013/mar/15/john-snow-cholera-map>).



The final example of key works is considered to be the best ever example of visualisation (Tufte, 1983; Friendly, 2002). It displays the losses suffered by Napoleon during the invasion of Russia in 1812. The piece uses brown lines to highlight Napoleon's army advancing, whilst black lines illustrate the retreat. The thickness of the lines shows size of the army at each particular moment, depicting that the army that arrives in Moscow is around one-fifth of the size of the army that began the invasion. It also shows the timeline of events by presenting the date, as well as the location, in the latitudinal and longitudinal points.

Figure 2.3. Napoleon's invasion of Russia, 1812 (Source: <https://thoughtbot.com>).



These examples illustrate the power of data visualisations, but it was only in the 20th century that people began to conceptualise how they worked. Bertin's (1983) seminal work on the semiology of graphics, for example, produced a foundational framework for analysing information visualisation. He identified various data types, such as categories, maps, numbers and networks, and retinal variables for visual encoding, such as position, shape, orientation, size and colour. The influence of this work can be traced throughout the development of data visualisation, and it has also cross-pollinated into other areas such as cartography. Few (2004) developed these principles, honing in on the role and application of colour in data visualisations. Few presented nine principles of colour in data visualisation:

1. The background colour must be consistent.
2. The background colour must show a contrast between background and object.
3. The use of colour must only be used for communicative purposes.
4. A different colour must be applied for differences in data meaning.
5. Natural colours should be used to display information, whilst bright or dark colours should highlight significant information to draw greater attention.
6. Designers should apply a single hue for sequential ranges.
7. For the benefit of those who are colour-blind, avoid using red and green in the same display.
8. Designer should avoid visual effects.
9. Non-data components should never overshadow your data.

This list is significant as it helps to illustrate the transition from Bertin's (1983) cross-hatch and shading principles into a more technology-based production, which suddenly allowed creators an abundance of colour choices in the creation and design of data visualisations.

The work of Bertin (1983) is fundamental to early approaches to communicative cartography (discussed in section 2.4.2), which are the roots of the post-representational approach mobilised in the analysis of this thesis. The above examples formed the foundation of what became the field of information and data visualisation. The following subsections will seek to examine contemporary data visualisation literature, firstly through interpretations of production, before highlighting the early works towards a more theoretical and critical data visualisation.

2.4.2 Data visualisation production

The literature in the field of data visualisation is rooted in best practice and in pathways of production. This reflects the practical focus of the discipline, which has somewhat neglected the critical and theoretical aspects of investigation. As Leegwater (2010) notes, there are now more visualisations being produced than there is an understanding of the conditions, circumstances and skills for building them. The following subsection looks into the literature on best practice to draw attention to the way in which data visualisations are produced, what drives inspiration and why particular conventions are utilised by broad range of designers. In so doing, it highlights the diversity of approaches to production, the different actors involved in the production process and the different cultures through which data visualisations emerge. Whilst highlighting the tools and practices of data visualisation, these examples also illustrate the lack of theoretical underpinning in this area of data – something which is addressed in Chapter 5.

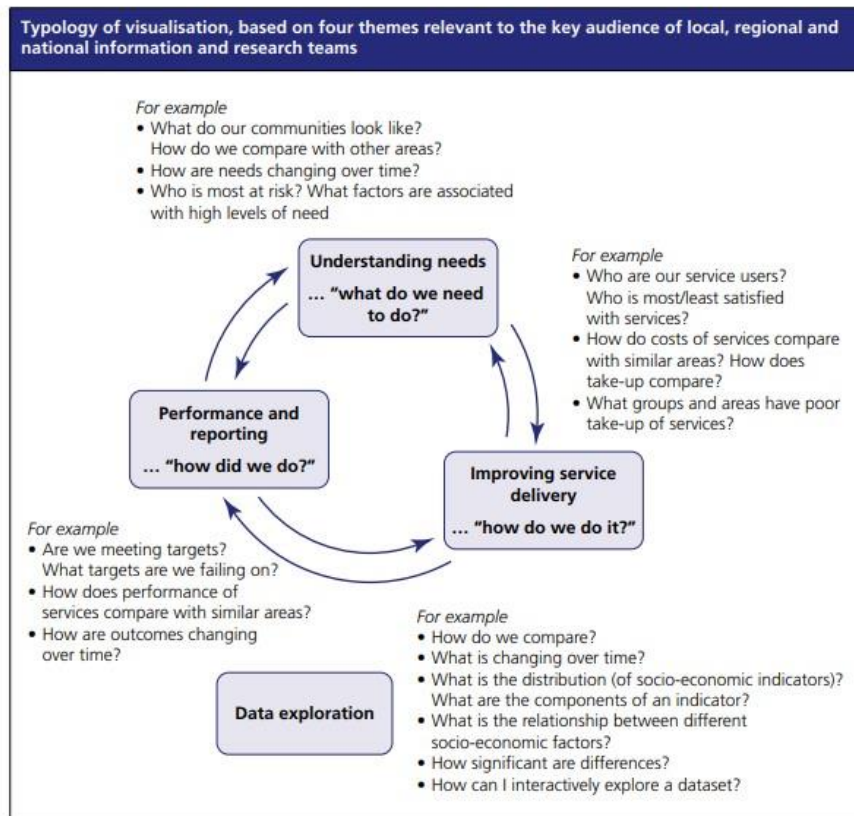
There are multiple potential paths to visualisation production. Lima (2009), for example, offers nine directions for any project to prevail to the aspirations of visualisation:

1. Form follows function; the purpose of the visualisation should be to explain and unveil the data that in turn leads to insight.
2. Every project should start with a question; having a defined query will help drive the work forward.
3. Interactivity is key; it is integral that users are able to reshape and investigate in order to find answers.
4. Citing your source removes any possible misconceptions and allows others to validate its authenticity. Each project should convey a message that creates a compelling narrative.

5. Do not glorify aesthetics; they should be a consequence, never an ultimate goal of a visualisation.
6. Look for relevancy in order to increase the possibility of decision-making.
7. Embracing time as a variable provides a much richer understanding of the changing dynamics of a social group.
8. Information visuals should be able to translate information into knowledge.
9. Visualisations should avoid becoming aesthetically gratuitous and making data representations more complex.

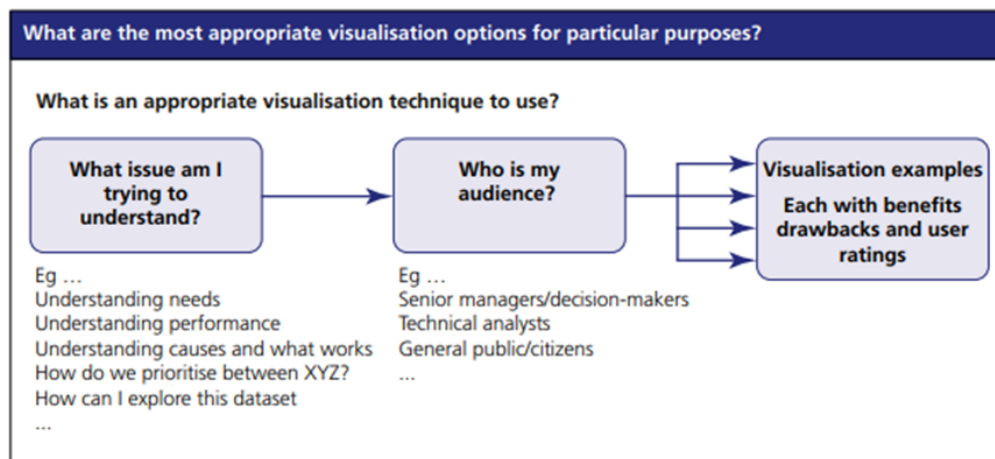
Knafllic (2015) suggests that there is five-point process to constructing a data visualisation. First is to understand the context, to know your audience and the tone of the piece. Second is to decide on the visual display, understanding the best chart type for your data. Third is to eliminate clutter, drawing upon the work of Tufte (1983) to remove chart junk. Fourth is to draw attention; this involves investigating colour and sight. Fifth is to make the design decisions; this refers to the aesthetic of the visualisation, from which form follows function. The design must be accessible in appearance to a broad audience, but aesthetically appealing. Similarly, Kirk (2016) suggests that there are four key principles of a data visualisation workflow. It begins by formulating the brief and initiating the project. The next phase is working with the data, which he identifies as gathering and preparing. Following that, the designer must engage their editorial thinking and question what they will show their audience. The final stage is to develop a solution, which is the beginning of the production and design cycle.

Figure 2.4. Smith et al (2009), the selection of typology of visualisation



The Ministry of Communities and Local Government issued a report which similarly explains the production of visualisations as a step-by-step process (Smith et al, 2009). This follows a similar pathway as the other guidelines for best practice. It focusses on the two key operational uses of data visualisation as a means of analysis and communication. It also recognises that it is not productive to identify each example of visualisation, and as such it is more productive to think of visualisations in a broad typography (Smith et al, 2009). In terms of the particular pathway, this approach similarly presents three steps to creating a successful data visualisation: to understand the issue, to know your audience and to select the correct chart type for your enquiry.

Figure 2.5. Smith et al (2009), production pathway of data visualisation.



The previous pathways are taken from key texts of data visualisation production. Whilst they are different in structure, there are key themes which reoccur in the above examples and in various other data visualisation texts. A generic example pathway may include the project initiation, working with data, understanding your audience, and chart selection and design decisions (Cairo, 2016; Sue and Griffin, 2015; Hinderman, 2015).

The interdisciplinary nature of data visualisation is highlighted by Kirk (2017), who suggests that in order to fully appreciate the complexity of data visualisation production, we need to appreciate not just the stages of production, but the actors involved. He argues that designers should adopt eight roles through the course of production. The ‘initiator’ of the project creates the idea and begins to source the data. The ‘data scientist’ is responsible for cleaning, merging, shaping and investigating the data. The ‘journalist’ is responsible for getting to the heart of the narrative, finding which aspects of the data to communicate. The ‘computer scientist’ role adopts the computer science approach to the visual representation of data, choosing the right chart type. The ‘designer’ is responsible for all the design decisions: chart type, colour, shape, scale, size and layout. The ‘cognitive scientist’ considers recognition and the audience’s ability to interpret the visualisation. The ‘communicator’ is responsible for tailoring insights to the audience’s ability, understanding its format, where it is to be released and what additional information is required. The ‘project manager’ oversees the entire project, maintains standards and makes sure the project meets its required deadlines. As well as literature on best practice, the field of data visualisation develops through actors staying up to date through blogs, social media and conferences (Hill et al, 2017), which allow ideas to be shared and accessed in a more instantaneous setting. This means that practitioners must remain up to date with developments through self-produced networks and interactions. It is these guidelines and norms which act as the professional watermark for

visualisation practitioners (Kennedy, 2016). The roles identified by Kirk (2017) are reintroduced through the local authority case studies in Chapter 3.

Kosara (2016) suggests that there are two cultures of data visualisation production: the very technical analysis and the artistic communication. He notes that the artistic is not pragmatic, focussing more on communicating concerns rather than on the data itself. The artistic visualisation approach suggests that flair and beauty can be mobilised to draw attention and to hold the gaze of the reader (Cairo, 2016). However, the opposing communicative science approach has its own principles. The use of colour should be used to provide meaning, not decoration (Cage, 2009), and designers should avoid using multiple shades of the same colour (Ware, 2004). Design decisions such as axis, scale and symbols should also only be used to enhance interpretation (Aiello, 2007; Kosara, 2016), form always following function (Knafllic, 2015). Few (2005) also suggests that designers should avoid using 3D charts as they reduce the audience's ability to read values, and that the chart should be clear of any 'junk' (Tufte, 2006). Despite this, Kosara (2016) suggests that there is a strong case for merging and cross-pollinating fields to make a

2.4.4 Chart type

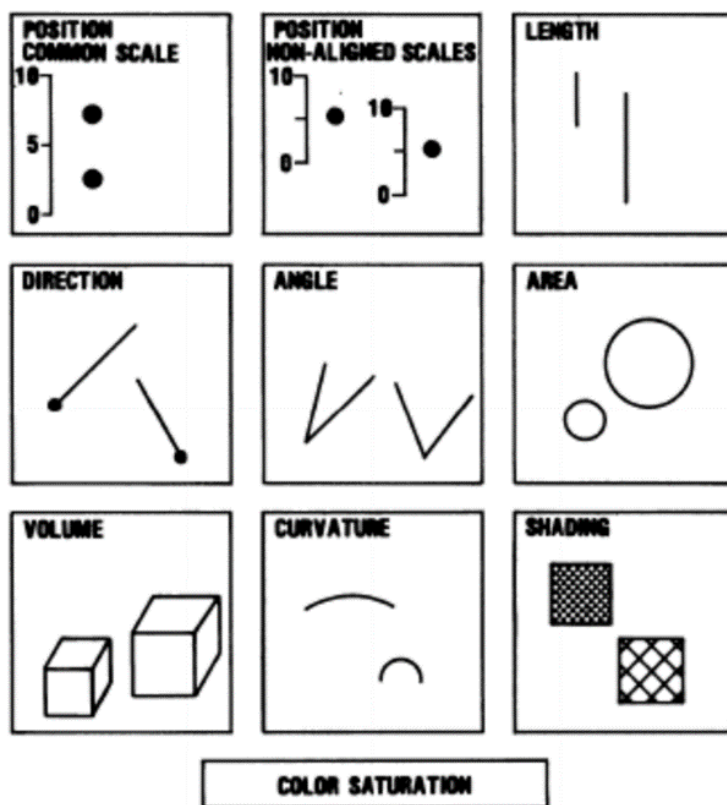
There are also best practice guidelines relating to the content of visualisations, but again these are subject to tensions between 'scientific' approaches and cultures of production. For example, the selection of chart type for appropriate data, although influenced by guidelines and best practice, requires some intuition from the designer (Evergreen, 2017). Although the popularity of data visualisation has continued to sprout an increasing number of new forms and variations in chart types, Friendly (2008) suggests that the core basis of all modern forms of visualisation was created in the 19th century. Due to the extensive possibilities of chart type, Evergreen (2016) suggests that it is more productive to categorise charts by purpose, rather than individually. Kirk (2016) develops this by suggesting five key chart types: categorical, hierarchical, relationship, temporal and spatial.

Kirk (2016) also gives three purposes for visualisations, from which the creator can attempt to shape the audience's interaction. He identifies visualisations as being explanatory, in which the user is given a specific message or narrative; exploratory, in which the user is given the opportunity to deep dive through more complex information; and finally exhibitory, in which the audience sees a standalone visualisation with no additional information or narration. Although this is useful in understanding the types of interactions audiences have, this interpretation works from the position of the visualisation as a representation and a 'readerly' text, as opposed to a writerly text in which the audience, in part, authors

its own meaning (Pickles, 2004). This is an idea from critical cartography which is discussed in more depth in section 2.4.8 and used in analysis in section 5.2. It is important to note here, however, that although these issues are discussed in relation to data visualisation, the nascent field has not fully engaged with the kind of philosophical approaches that would lead to better theorisations of data visualisations.

It is more common that the data visualisation field focusses on more scientific approaches to understanding. The work of Cleveland and McGill (1984), for example, is a foundational text in the perception and interpretations of visualisation. They created a hierarchy of chart types, ranking from easiest to most difficult to understand. At the top was common-scale and non-aligned scale graphs. The tier beneath included length, direction and angle, and the final tier included area, volume and character. Whilst there have been developments of this work over time, it remains influential in numerous best practice guides of visualisations (Evergreen, 2017).

Figure 2.6. Cleveland and McGill (1984), hierarchy of perception.



Technological advances have meant that the inclusion of shading has been replaced by more in-depth research into perceptions of colour, with Ware (2004) noting that humans can only interpret four shades of the same colour. Other developments in perception have focussed on chart junk, parallel lines, the

use of 3D and various new shapes and chart types (Ware, 2000; Spence, 2001; Few, 2004; Tufte, 2006; Strange, 2007; Few, 2011). Whilst this is beneficial, the role of socio-cultural factors of engagement has been largely neglected from academic visualisation research (Hill et al, 2017). Therefore, this presents an opportunity for this research to interpret data visualisation through a post-representational cartographic lens. As I discuss below, such an approach will give insight into the roles of the aesthetic, technical, social, political and embodied processes which influence audiences' engagement and practice of data visualisations. These ideas are to be discussed in greater depth in the following section (2.4.8). The ideas discussed in this section are, however, useful in providing a framework for unpicking the particular pathways of production in the local authority case studies, and are analysed further in Chapter 4. Moreover, the diversity of ways of understanding the pathways of production illustrates the need for more theoretical engagement with data visualisations.

2.4.5 Critical data visualisations

This subsection examines the beginnings of a critical data visualisation which attempts to address some of the issues highlighted above. It highlights interpretations of the roles of actors and intermediaries and draws attention to the growing works which draw attention to the need for a critical data visualisation. This subsection also takes the first tentative steps towards the application of critical data visualisation research, as academic focus begins to shift away from best practice and towards deeper understandings of data visualisations.

Although the processes of production outlined in the previous subsections highlight different pathways of production, it is also noted that processes of mobilising data graphically are often not conducted in isolation by a sole actor (Gitelman and Jackson, 2013). Rather, there are a series of decisions, compromises and exchanges between actors and intermediaries (Kirk, 2016; Evergreen, 2016). This is especially relevant in fields such as data journalism, where the decisions made by the designer are often in keeping with those of the particular editors, legal departments and those commissioning the piece, who ensure that the work is in keeping with the required perspective and tone (Kennedy, 2016). The production of data visualisation has also been challenged in recent years due to its associated objective assumptions, in which the designer remains supposedly neutral and the design is a reflection of the 'raw data'. Couldry and Powell (2014) highlight the lack of attention in research to the social actors and groups of actors, in a variety of places and settings which influence data visualisation production. Similarly, Ambrosio (2015) suggests that in order to fully understand the production of data visualisations, we should consider them as a series of choices made by actors and intermediaries. This is an idea which has been developed further, firstly by Kirk (2016) and most recently by Kennedy (2017), who suggests that the roles of actors and intermediaries are themselves influenced by the

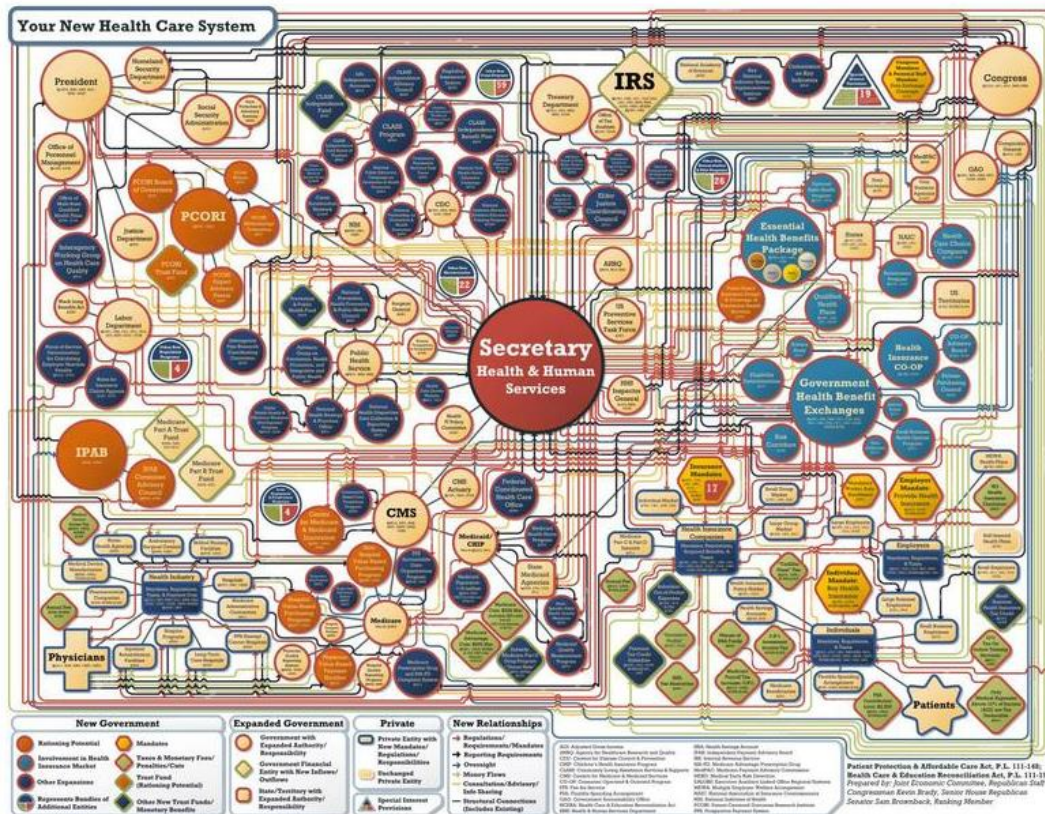
decisions and priorities of the organisations which created them. This idea has its roots in critical cartography and in particular the work of Harley (1988), which is discussed further in section 2.4.3.

The assumed objectivity of data visualisation is also highlighted as a potential avenue for exploration. Coopmans et al (2014) critique the perception of a visualisation as a window onto data. Ambrosio (2015) notes that rather than being manifestations of data, visualisations are informed by judgement, discernment and choice. Despite this, they can be perceived as neutral and as such they have the power to influence the user's perception of how the world works (Barnhurst, 1994). Porter (1995) draws attention to the idea that numbers and statistics in a visualisation are historically trusted, as they appear universal, impersonal and neutral. In their visual depiction, numbers give the illusion of being coherent and tidy (Rupert, 2014), acting as the translator between complex world and human observer (Halpern, 2014). In doing so, they perpetuate existing power relations and create new ones, and as such they do ideological work (Swords and Liu, 2015).

Recognising the political nature of data visualisation is becoming more prevalent in the academic research. Boehnert (2016) draws attention to the role of data visualisations as presenting truth claims which privilege certain perspectives, and the idea that users should always remain critical and inspect both what is being told and what is not being told in the visualisation (this work is revisited in section 5.5 and used as a framework for analysis). Although visualisation practitioners do not share the same language as critical commentators, they are aware of the multiple choices of production, which can privilege certain perspectives (Hill et al, 2017; Kennedy, 2017). Kirk (2016) offers one solution to this issue and suggests that all treatments and transformations must be noted and shared with users to provide clarity, openness and transparency.

Simplicity in design is also said to present a coherent and tidy argument (Rupert, 2014) which conceals a more complicated reality (D'Ignazio, 2015). Simplicity, or otherwise, in data visualisations is mobilised as a tool, harnessed for political means. Valarakis (2014) illustrates this by examining the US Republican health report, which is presented as an unreadable knot of tangled and intertwined flows. The aim of the visualisation was not to be understood or to depict knowledge, but instead to present users with the idea that the healthcare policy was too complicated and ultimately unreadable and unworkable (Dick, 2015).

Figure 2.7. US Republican health report, 2010 (Source: <https://flowingdata.com>).



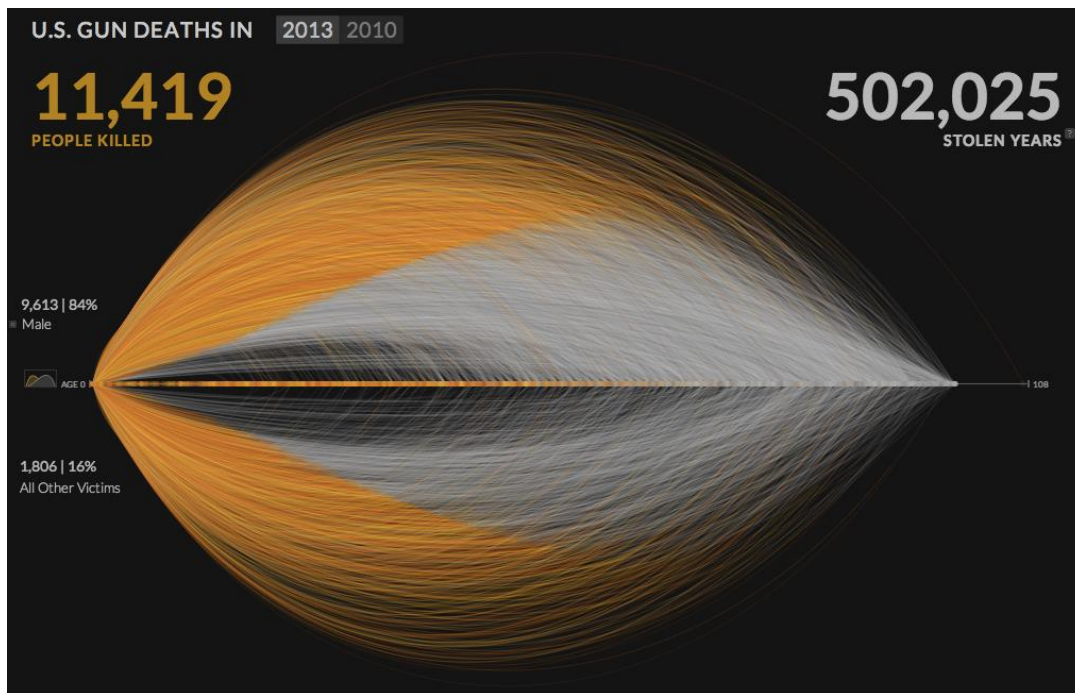
Taking steps to understand the work of visualisations in perpetuating truth claims, Kennedy et al (2016) investigate the role of design conventions in unpicking the ideological contradiction between being persuasive and being transparent. In their research, they argue that it is not the designers who are persuasive, but the design conventions that are the standards of a professional and well-made visualisation which create the sense of objectivity. To illustrate this, they mobilise a social semiotic approach, which highlights the cultural histories and political implications of conventions which are considered natural or taken for granted (Aiello, 2006). Their research presents four key conventions, by presenting a two-dimensional layout from forward-facing or top-down position, gives a god-like perspective (Harding (1986) of seeing everything from nowhere (Haraway, 1998; Leeuwen, 2006). Presenting simple, repetitive geometric shapes is considered universally true (Hill et al, 2017). Following from Tufte's (1983) depiction of clarity as the least amount of ink to page, Kennedy (2017) argues that the removal of chart junk adds clarity and simplicity, which produces a persuasive effect. Finally, adding the data source creates transparency and gives the impression that the designer is confident and truthful. Kennedy (2017) argues that the public, untrained user may not be able to make sense of the 'raw data' and therefore critiques this convention as a means of transparency and openness.

Figure 2.8. *Legend* film poster utilising chart junk to disguise a two-star review, 2015 (Source: <https://www.independent.co.uk>).



There is also a growing need to understand the role of emotion in interpreting data visualisation. Its importance has been recognised in other fields of design (Norman, 2004), but it is still an area ripe for enquiry in data visualisation. Kirk (2016) draws attention to the way users interpret visualisations on a sliding scale moving from ‘reading’ to ‘feeling’. Kennedy and Hill (2018) suggest that emotional responses to visualisations occur due to a mix of the data, the style, the subject, and the source of the data and the skill of the user to interpret.

Figure 2.9. Periscopic US gun deaths graph to highlight ‘feeling’ and the emotional response to data visualisation, 2013 (Source: <https://guns.periscopic.com>).



Iraq's bloody toll

Firstly, criticism must be expressed in a neutral voice, presenting the most balanced possible light. Secondly, statements must be backed up by independent facts; anecdotal evidence is not enough on its own. Thirdly, critics should avoid using their own work as positive examples of work. Finally, each critique must serve a goal in line with providing an alternative solution, which could be the basis for further research (Kosara, 2007).

Critique as a means of development and forwarding the field is also proposed by Viegas and Wattenberg (2015), who argue that critique by redesign can be uniquely successful in visualisation – offering an approach that is simply not possible in the world of art or film – and in order for the field to gain the most from this approach, designers and redesigners should approach their work with the same objectives and goals. Also, there should be a mutual respect and recognition of the work of both the original designer and the critic. This will open up an intellectual conversation between both parties and, as a result, remove the adversarial nature of redesigns, which can improve the field as a whole. Within this approach, visualisations would be recreated using the same data sets. This provides an alternative understanding of the issues and an intellectually honest direct comparison between approaches, whilst removing any aspects of authoritarian academic hierarchy. However, this is also problematic as a visualisation that is redesigned after the original removes the complex context in which it was originally created. Viegas and Wattenberg (2015, 4) declare that ‘design is a compromise’, reflecting a series of hidden tactical constraints, goals, strategies and political pressure. Therefore, to recreate the visualisation without these added pressures will most likely be detrimental to the original. Furthermore, as the recreation is created with hindsight, the author already knows the answers to the questions that the visualisation intended to solve. As such they are able to identify key variables in order to reinforce their own argument.

In this section I have illustrated that there is a recognition of the need for a critical investigation of data visualisations. Despite there being a growing body of work in recent years, the literature currently focusses on highlighting areas of potential investigation and remains disjointed and sparse as a field of study. Contemporary research continues to adopt and borrow from related fields due to the lack of its own theoretical frameworks; this is illustrated first by the social semiotic approach and then through the work of Tufte (1983), which is rooted in computer science. This highlights the need for a data visualisation framework which considers both perspectives of best practice and theoretical implications, which is an area this thesis addresses by adopting a post-representational cartographic lens. The works which challenge objectivity, power and the roles of organisations as creators are all rooted in critical cartography (which is to be discussed in the forthcoming section). This research seeks to move beyond

this conceptualisation of maps as representations, instead considering them as processual, which will be discussed in depth in the following section 2.4.8.

2.5 Cartography

Cartography has a long and rich history within geography; its areas of study are all tied to the representation of data visually. Therefore it presents an informative comparison and adjoining discipline from which to explore data visualisation. As the following sections depict the chronological development of cartography, attention is drawn to the multiple similarities to the field of data visualisation. There are also many overlapping theoretical developments which can be considered as comparisons to data visualisations. By presenting the changing paradigms in cartography, I aim to illustrate how these interpretations of cartography can be applied to enhance our understanding of data visualisation. This section begins by exploring historical cartographic research, beginning with the functionality model and the ensuing paradigm shift, which placed emphasis on a cartography of communication. Following the critical turn, cartography began to shift towards a more nuanced deconstructionist approach in the late 1980s, which led to a fractured, somewhat directionless decade in which no theoretical approach gained enough momentum to succeed in creating a defining paradigm. More recently, there has been a reframing of cartography and the development of a paradigm – post-representational cartography – which seeks to challenge its ontological assumptions. The following subsections trace these paradigm shifts and theoretical developments in order to signpost the works which are to be used in exploring, explaining and interpreting data visualisation in this research.

2.5.1 Functional cartography

A growing desire to formalise cartography can be traced back to 1910 (Wright, 1930). However, it is argued that the work of Raisz (1930) in *Principles of Cartography*, noted for its wide-ranging influence, is the seminal piece and was heralded as cartography's formal introduction. Raisz's (1930) work utilised technical nous and a keen eye for detail, as he illustrated the physiography of landscapes by hand (Crampton, 2009). Following the Second World War, the work that Arthur Robinson and his team had conducted as the cartography department of the US government, combined with growing angst towards cartographic manipulation and misdemeanour, had emerged in propaganda. A movement to segregate the artistic, aesthetic aspirations of creation with the regulated, tested and theorised scientific field emerged. Robinson (1952) likened map work to architecture, stating that buildings designed for a purely aesthetic purpose were simply not functional. Detailing his scepticism for arbitrary and capricious decision-making in map design, he proposed two options in order to push forward a scientific

framework of the discipline. The first was to standardise all signs and symbols in order to remove any confusion that might occur in their meaning. Whilst there may have been a few contributions to this area of discussion (Ratajski, 1971), largely it was not taken seriously by cartographers (MacEachren, 2004), which left his second suggestion as the driving force of the discipline. This suggestion was that cartography should be developed in accordance with design principles based on characteristics of human perception. By taking a positivist scientific view of map design, it becomes possible to test the signs, symbols, lettering and colours for their effectiveness, leaving the cartographer with the most appropriate and valuable solution in presenting the spatial data (Crampton, 2009). The functionality approach, which emphasises the importance of objective perception tests, has been critiqued for failing to account for human variability within the perception spectrum, as well as neglecting the true value of art in cartography. This links with the current fields of information visualisation and more broadly with the scientific approaches to data visualisation which focus on perception and recognition.

2.5.2 Communication model

It wasn't until the late 1960s that the emphasis and focus within cartography started to shift. The idea of a map as a tool for storing spatial data had become stale and cartographers began to focus on how effectively their spatial data could be consumed, communicated and understood. Board (1967) depicted map creation as a process, with decisions which are made during design being ultimately responsible for how well the map is received. The communication paradigm outlined a need to understand and conceptualise the ways maps communicate their intended message to an audience, derived from the idea that a map contains a variety of elements that are used to communicate information. Communication theory therefore attempted to use scientific investigation to design each of these elements to improve their communicative potential. This new approach coincided with the general trends of spatial science and, methodologically, cartography followed suit and becoming concerned with formalised modelling (Crampton, 2009). The first published model of communication was developed by Kolacny (1969) and was widely recognised to have had the furthest reaching influence of all the communication models, although it has been heavily critiqued for its complexity, incorporating multiple feedback loops. This approach does offer a valuable interpretation of cartography. In a simplified version of the model, Crampton (2010) illustrates its main objectives, depicting that the geographic information is gained by the cartographer and transferred to the map itself. The map is then viewed as a vehicle to communicate information to the percipient, who then responds by offering feedback to the cartographer.

Figure 2.11. Kolacny communication model, 1969 (Source: Bo et al).

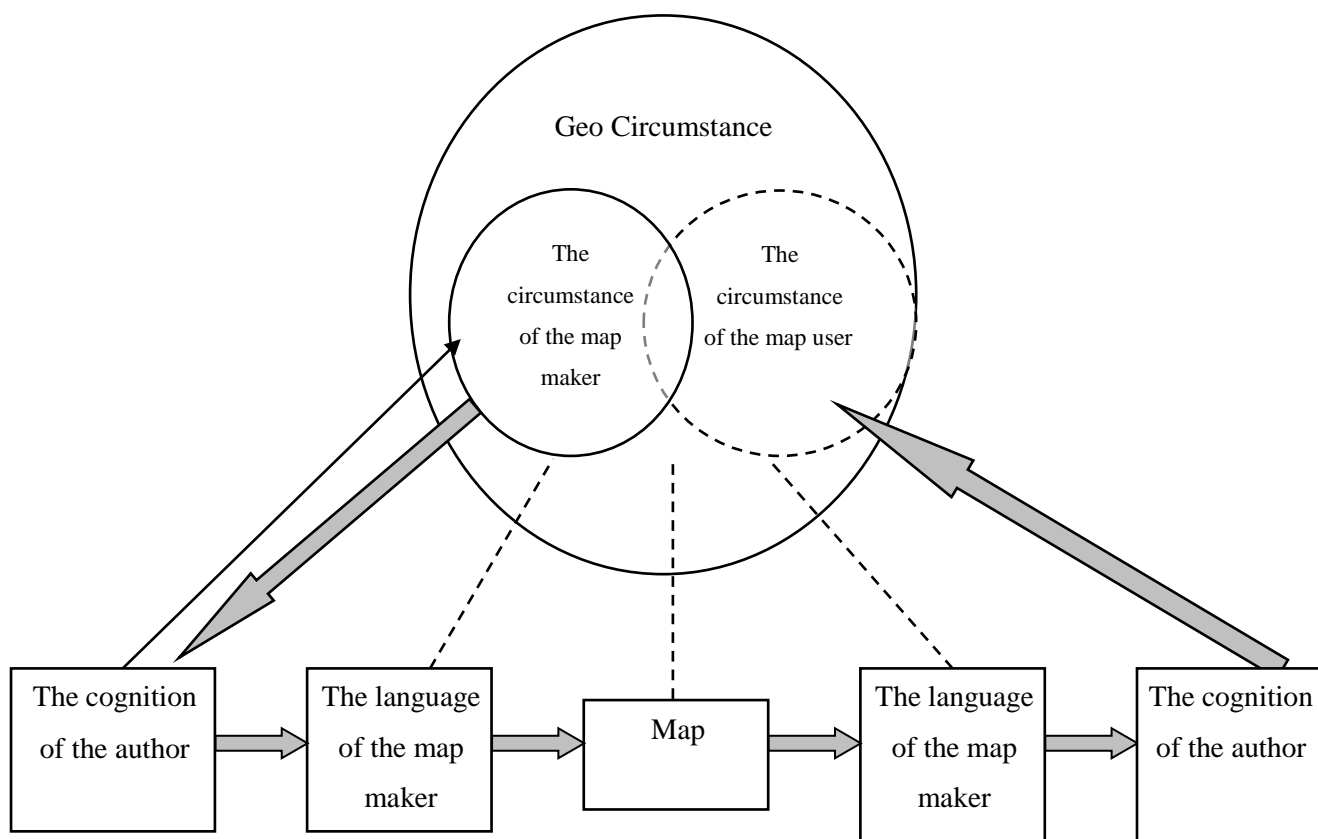
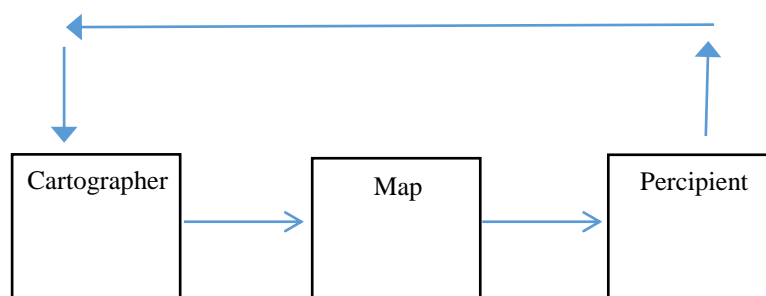
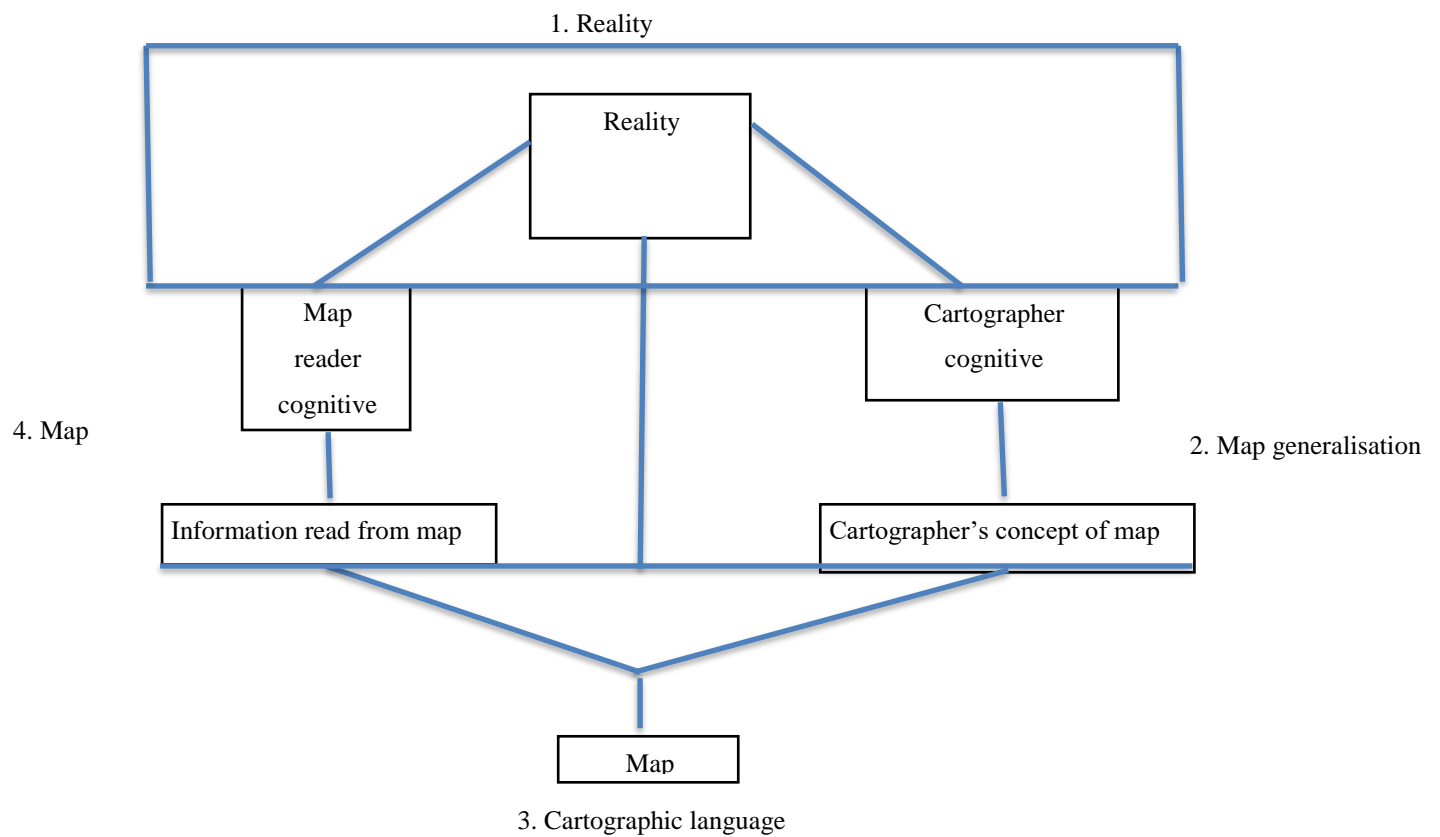


Figure 2.12. Simplified Kolacny communication model, 1969 (Source: adopted from Crampton, 2010).



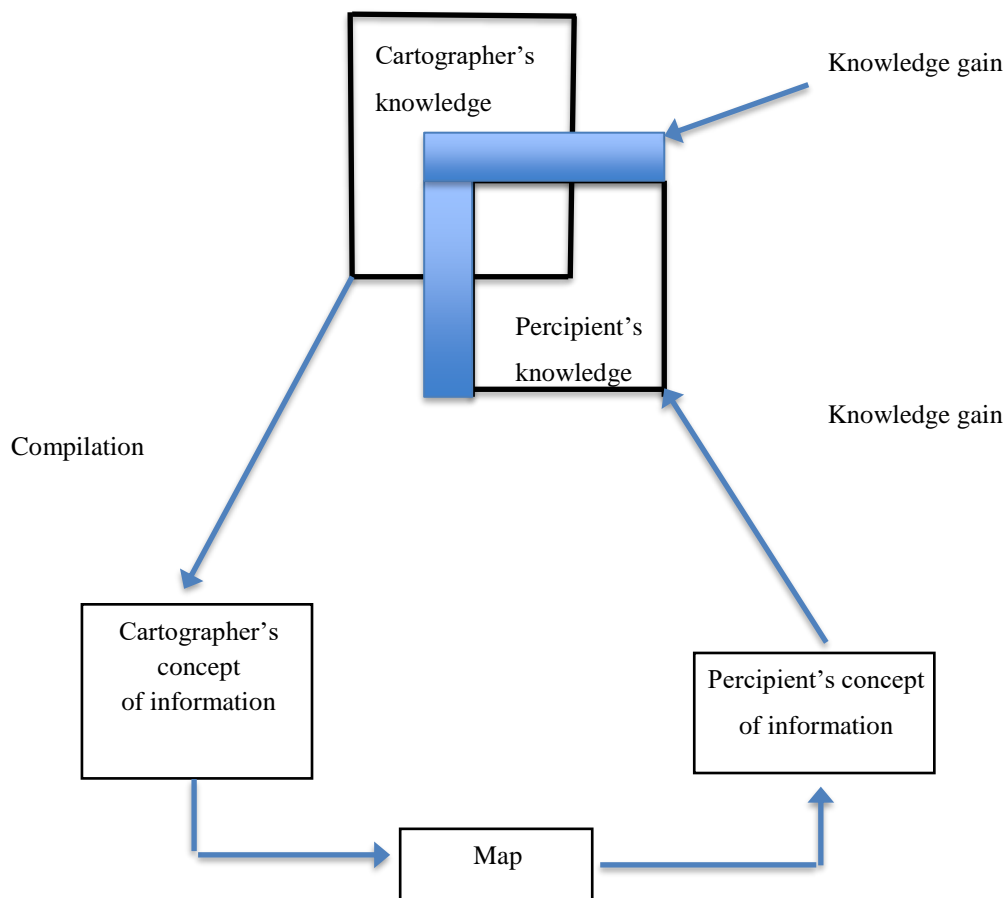
This work was later expanded upon by Morrison (1976), who unpicked the role of the cartographer in extracting geographical information from the environment. In his model, data collection is followed by decision-making as to how to generalise categories, followed by the action of map design. This model was significant as it was the first to address design decisions made by cartographers.

Figure 2.13. Morrison communication model, 1976.



Finally, MacEachren (1979) developed the most substantial cartographic communication model. It outlined all the possible factors which could inhibit information transmission, resulting in loss or miscommunication, from both the cartographer and the map reader. Whilst the user is responsible for incorporating elements such as their own objectives, knowledge, experience, abilities and client demands, the map user's goals, ability, viewing time, preconceptions and intelligence are also key to the successful communication of data.

Figure 2.14. MacEachren cartographic process of communication, 1979.



Whilst the communication model has enjoyed success, especially with regards to expanding the theoretical approach to cartography, it has also been widely criticised (Harley, 1989; MacEachren, 1994). Communication cartography often became associated with sterile maths-based problems, removing the creativity and aesthetic appeal it once had. Another critique of the communication model is the assumption of objectivity and neutrality in map design, with the cartographer being implored as a neutral vessel whose only action is to utilise scientific protocol to increase communicative effectiveness (this again reflects current critiques levelled at data visualisation). Whilst we are able to accept that cartographers worked under the premise of objective communication rules, exactly what and how to map remained a subjective judgement, therefore delegitimising its underpinning philosophy. The cartographic communication model has also been critiqued through its definition as communicating the function of a map. The precise meaning of the term ‘function’ is both conflicting and contested. Whilst generally it is used to identify the purpose of a map, in this instance the function is stifled to mean ‘a predetermined message’ (MacEachren, 1995). This becomes particularly problematic when addressing the cartographic communication model, as only a small subset of maps communicates a predetermined message (Wood and Fells, 1986). For example, topographic maps, maps showing the locations of events and travel maps all have a purpose and function, but don’t necessarily have an

explicit predetermined message to convey. Often it is not the predetermined message of a map that is communicated, but the answer to the individual queries set by the map reader (which can be seen in current data visualisation work). These are usually solved by combining map information with previous knowledge in order to produce conclusions that were not necessarily part of the map's intended message.

2.5.3 Continuing cartographic thinking

Bertin's (1967) work on the semiology of graphs, as discussed in section 2.2.1, has been prominent in the field of data visualisation. It remains a founding text in graphic design and it also provided a great framework in which cartographers began to delve into graphic theory in order to advance their own agenda. He states that graphics are a language for the eye and as such should be given the same academic interest and importance as written text. He depicts three functions of graphic representation which are all applicable to cartography and data visualisation: recording, communicating and processing information. Although not the first to make reference to cartographic communication, Board (1972) provided the first sustained attempt to establish theoretical principles. His theory is based upon the notion that graphics and maps are part of a wider semiology in which style, difference and the look of an entire map should be analysed. This approach, it is said, will allow us to depict periods of cartographic history through certain styles, which he terms as the 'human factors approach'. Ratajski (1973) elaborated upon Board's communication theory and identified two elements of cartography which needed to be developed. He argued that the basic principles of map design should be elaborated upon in order to give an insight into the cartographer's aims, skills and principles, followed by an evaluation of both the effectiveness and efficiency of the communication. Morrison (1976) agreed that cartography should be recognised as a science of communication and information, and he set out three guidelines for the future creation of maps: the selection of information, the classification of data, and its simplification in order to best communicate a message. These thoughts echo the data visualisation production guidelines which have been discussed above.

Robinson (1976) began to develop the idea of effective communication by stating that maps are a representation of one's milieu, and penning the term 'mapper'. This refers to both the map maker and the map viewer and illustrates the mental processes of both producing and consuming a map (Robinson, 1976). The map maker is a 'mapper' as he envisages in his mind what he then effectively transcribes onto material, whilst the map viewer reads this inscription and recreates a map in their imagined space. There has been a long history of conflict between the scientific and artistic aspects of cartography, dating back to Robinson's (1952) initial scientific push through to MacEachren's (1979) communication model. The idea of legitimising the objectivity of cartography through scientific experiment is both understandable and commendable. However, both of these paradigms have been

critiqued for overemphasising the importance of the scientific and, by comparison, neglecting and devaluing the artistic understanding of cartography (Keates, 1984). By segregating art from cartography, we are neglecting the field from several key characteristics, which are widely considered to be beneficial. Keates (1984) argues that an inclusive artistic element of cartography would allow for a greater emotive, expressionistic and imitative approach, whilst a reconciliation between science and art only seems beneficial to the communication paradigm. This debate from 1984 is reoccurring in contemporary data visualisation, which again highlights the connections between the two fields.

2.5.4 Critical cartography

Following the positivist objective science view of cartography during the 1970s, a new set of scholars, theories and frameworks began to develop at the end of the 1980s which would eventually come to prominence throughout the 1990s (Crampton, 2006). Based upon assumptions of power, ideology and surveillance, scholars in cartography began to challenge the discipline's own history, ethics and values. This subsection looks at this critical turn in cartography and follows its theoretical development until the present day.

Harley (1989), disillusioned with the way in which cartography operated behind a 'mask' of neutral science, stated that cartography is seldom what cartographers say it is. He outlined a new deconstructing framework that was as interested in the processes, ideals and tools of construction as with the final outcome (Harley, 1989). By deconstructing maps, scholars were able to build a new theoretical background of cartography which placed each map in its own historical and social context. In keeping with Wood and Fels (1986), he states that maps construct power through their production tools and thus, through his deconstructing theory, we can reveal values related to ethnicity, politics, religion and social class.

By deconstructing, Harley (1988) suggests that cartographers should also begin to look at the 'silences' on maps. These spaces are the unique or 'blank' on maps in which power is constructed and personified (Harley, 1988b). Harley states that there are two forms of silence: the intentional (censorship) and the unintentional (the premise that to include certain things on a map, others are misplaced). One of Harley's final works underpinned an idea for cartographic ethics. Here he critiqued cartography's self-governing analysis as a purveyor of the precise, accurate and exact truth (Harley, 1991). He returned to his earlier work, stating that the aesthetics of cartography is not value free, and brought his thoughts on ethics to three major conclusions. Firstly, the notion that most maps are derived from predetermined information means that they may already be censored and cannot therefore be ethically challenged. Secondly, the power of maps means that they can influence the way people think and act upon social

issues, and therefore cartographers must be aware of this within their work. Finally, maps often mirror majority values, determining that a good map for one society is often not good for another (Harley, 1991). Despite its long-standing influence and its importance in developing a critical approach to cartography, Harley's work has been critiqued on numerous occasions. Wood (1992) suggests that, despite Harley's forward, dynamic approach, he remained unable to fully challenge the idea of a map as a reflection of the world. They argue that no matter how subjective, selective or partial, it remained a true yet agenda-driven artefact. They argue that he was unable to challenge the representational understanding of a map as his own philosophies were entrenched and embedded with those he critiqued (Crampton, 2003), and that, to Harley, no matter how subjective, engineered or dubious, a map will always be a reflection of the world.

Despite his aims to redefine map history by unveiling hidden agendas, politics and power, Belyea (1992) suggests that Harley's own work was engineered by utilising a very selective group of sources. Sparke (1995) suggests that, despite Harley's intentions, what he actually proposed could be considered a demythologising rather than a deconstruction of the map, and that Harley's idea of deconstruction was not a full and fair depiction of the ideas of Foucault (Belyea, 1992). This is a point which Crampton (2010) summarises by simply suggesting that Harley's ideas were not those of a social scientist but those of a map historian. Notwithstanding this critique, Perkins (2003) shows some understanding of Harley's works by suggesting that his untimely death in 1991 meant that his ideas were never brought to their natural conclusions. Despite its noted flaws, the idea of deconstruction was significant in introducing a critical understanding to the field of cartography. Because of this, it remains extremely influential and significant within the field.

The move towards a critical model of cartography not only seemed to differ from the previous paradigms, but was recognised as being in direct opposition to them (MacEachren, 1995). The work of Harley cast doubt upon the methods and practicality of previous cartographers. It also questioned their integrity, motives and agendas. Irrespective of other contributing authors within the changing paradigms, the conflict between the critical and communication schools of thought appears to have been retrospectively personified as a personal duel between Harley and Robinson (Crampton, 2010). The retrospective readdressing of cartography, which Harley sought, almost attempted to devalue and undermine all previous works. This has prompted scholars such as Edney (2005) to question the benefit of retrospectively applying theoretical advances to historical maps, instead pressing for a non-progressivist history in which the past is recognised as the past – no better, no worse, just different. These debates are also occurring in the current field of data visualisation – as noted in the previous section with the works of Viegas and Wattenberg – and calls for a critique of redesign have been

criticised as being adversarial and lacking devaluing past works by critiquing them outside of the original context in which they were created.

The previous section has begun to introduce the concept of critical cartography. Following the work of Harley and others in the field, critical cartography continued to grow and take shape into something more than the initial theoretical critiques outlined in the previous section.

Critical cartography is broadly associated with having developed in the late 1980s in opposition to the post-war epistemologies of mapping. Whilst this time was key to stimulating growth, the notion that maps are not simply objective reflections of the world dates back much further (Wright, 1942) – for example, to the psychogeography of the 1950s and 1960s (Crampton, 2009) and even to the 1929 surrealist map of the world which was reproduced by Pinder (1996). However, it wasn't until the 1990s that it became a prominent subdiscipline within the field, with authors such as Woods (1992) drawing attention to the ways in which maps express interests which are often hidden from sight. Whilst critical cartography can mean many things (Shephard, 2015), Gall (2011) highlights that it generally refers to the work that exposes the ideologies embedded within maps and their social effects, as well as the proactive efforts to create alternative maps (Elwood, 2010). Crampton (2006) furthers this and describes critical cartography as a 'one, two punch' of new mapping practices and theoretical critique. This definition is significant as it highlights the ways in which critical cartography has become inclusive to multiple, alternative cartographic traditions (Woodward and Lewis, 1998), opening the field to new worlds, societies and knowledges, concepts and practices (Harley and Woodward, 1987; Rolnik, 1998). This brought a focus towards the role of maps in experience rather than form, which opened the door to non-traditional and non-Western maps. For Guttar (1998, 12), 'a map is open and connectable in all of its dimensions, it is detachable, reversible and susceptible to constant modification. It can be torn and reversed [...] It can be drawn on a wall, conceived as a work of art, constructed as a political action or as a meditation.'

Crampton (2009) notes that maps articulate statements that are shaped by social relations discourses and practices and are therefore always political. Maps call things into question; they examine the relationships between knowledge and power and what assumptions help govern knowledge. They author meaning to space by creating specific, spatial knowledge by identifying, naming, categorising, ordering and excluding spatial information. Once in play, these categories can be used to exert power and control over people and things, ultimately creating knowledge as much as reflecting it. Authors and creators are responsible for what is chosen to be represented, how it is to be represented and for each

incremental decision throughout the production process. As discussed in section 2.4.6, these decisions are being made by increasing numbers of participants, and maps are present in more people's lives than ever before (which is discussed in relation to data visualisation in Chapter 5).

Crampton (2006) highlights four key areas for the development of critical cartography, each of which has developed to become pivotal to cartography becoming a more inclusive field and interpreting how maps work in the world. The themes outlined in the following section, in particular the critiques of cartography drawn from these fields, share many similarities with data visualisation, which are drawn together through the discussion in Chapter 5.

Theoretical critique

Identified above and throughout section 2.3, the development of critical cartography has allowed scholars to challenge the assumptions of maps and spatial knowledge. The work of Harley (1989) in deconstructing the map, Peluso (1995) in the counter-mapping of indigenous forest areas and Pickles (1998) in depicting maps which are used for divisive ends highlight departures from the objective map assumptions from the communicative paradigm. The theoretical developments within critical cartography were addressed in more depth in the previous subsection (2.4.4).

Critical cartography has also allowed for investigation into mapping the everyday. By exploring everyday social experiences of place, we can also investigate the role that map practices play in knowledge construction and identity (Perkins, 2004). This has led to a much broader field of map theory and practice. Wood (1993), for example, explored children's perspectives of place by mobilising children as map authors and readers. Ingold (2001) depicted the narrative re-enactment of journeys made by participants. Brown and Laurier (2004) highlighted the complex negotiations of identity in a social context as day trippers planned weekend car journeys. Furthermore, the work of Till (2003) described how new Berliners use maps and guidebooks to relate to the rebuilding and remapping of their city as they become locals, and Brown (2004) highlighted the role of tourist books and guides in informing a sense of place. Everyday mapping also allows for a more inclusive, performative and participatory account of mapping (Krygier, 2006; Swords and Jeffries, 2015), allowing for simple hand-drawn maps to be created to empower different types of social groups and local communities, as well as the incorporation of other non-Western forms of mapping (Peluso, 1995), which are discussed in more depth in the following section (2.4.7).

Map hacking

Crampton (2006) also notes that map hacking (also known as ‘map mash-ups’) could be key to producing spatialised knowledge in a new way (Kanarinka, 2006). As more maps become available digitally, users can edit, overlay and mash-up maps with their own geographical data. Using a traditional ‘map mash-up’ approach, users are able to annotate Google Maps using numerous sources of data and images in order to create a new single interface (Monmonier, 2007). Mash-ups have emerged as a relatively inexpensive way of making existing data more useful and personal, and ultimately allowing participants’ authorship (Crampton, 2006). Despite promising notions of ownership and empowerment, map hacking has also been critiqued as it still operates within the rules and structures of the dominant group (Farman, 2010) (these ideas are discussed further in section 2.4.6). Maps are authoritative resources that states use to mobilise to consolidate their own power (Harley, Kain and Baigent, 1992). However, if local groups can appropriate that technology, they may begin to counter-balance or offset the monopoly of the state (Menzie, 1992). Counter-mapping can therefore be used to facilitate, delineate and formalise claims for resources and territories. It can provide local groups with the power to claim land and resources through official forms, and can be used to pose alternatives to the language and images of power and become a medium of empowerment and protest (Peluso, 1995; Brown and Knopp, 2003). Peluso (1995) draws attention to the role of forest mapping in Indonesia, which was embraced by early European states for establishing political boundaries. Forests provide many valuable assets, such as timber and minerals, and she claims therefore that mapping forest resources is an intrinsically political act. By adopting a counter-mapping approach, Peluso (1995) utilised traditional indigenous forms of claims to land, such as songs, performance, folk tales and pictures, to create a Western map which acts as a formal claim to land within the visual construct of Western cartography. Indigenous counter-mapping in this sense has been critiqued as solidifying the fluid and flexible boundaries of land use once they become fixed with Western cartography (Fox, 1998). Indigenous counter-mapping projects have also been critiqued for leaving the authority and power in the hands of the imported expert (Johnson, 2006). Maps as resistance and counter-mapping are discussed in relation to empowerment in section 2.4.2.

2.5.5 Persuasive and deceptive

The previous sections have discussed the critical turn in cartography. Following this work, the field of cartography entered into a period of investigation. This period between critical cartography and post-representational cartography brought with it some notable works which expanded notions of critical cartography and explored in much greater depth the politics of cartography. The following section explores various practical case studies which illustrate the ways in which maps have been used to reinforce a certain and specific view, attempting to validate certain knowledge and remove others. Maps are inscribed with the historical context in which they were created, which often reveals as much about

society at a specific time as the world it proposes to reflect. The map as an artefact carries an assumed knowledge and factual integrity which is often misplaced (Crampton, 2006).

The first example of this is what Tyner (1974) referred to as persuasive cartography, in which propaganda replaced the much sought after objective truth and users struggled to differentiate between accurate spatial representations and the politics of the reader (Pickles, 2012), producing maps that were not only 'visually believable but convincing' (Ager, 1977, 1). Propaganda aims to persuade and coerce large groups into believing certain things and behaving in certain ways which may not be considered ordinary (Pickles, 1991). Monmonier (1996) suggests that there is no other period in history where maps have been so blatantly and persistently used for propaganda as that by the Nazi Party during the Second World War. They frequently published maps in American newspapers in order to gain sympathy and keep the USA out of the war. The most notable of these are a map illustrating the 'hunger blockade' which Britain had enforced upon Germany, and a 'study of empires', illustrating the decline of Germany following the First World War. Both of these examples were published in *Facts in Review* magazine in New York, during the war. They have also been used as tools for misinformation; during the Second World War, the Russian government deliberately produced inaccurate maps as a means of creating security in the event of being invaded, knowing that if enemies began to attack, they would hold the tactical upper hand (Pickles, 2011). These examples, although extreme, illustrate the power and control of visual information, whilst differing in terms of both objectives and outcomes. They all follow a common theme in which maps are often unquestionably assumed to be accurate, truthful and objective. An understanding of this is significant in terms of data visualisation as it allows us to take a critical approach and disseminate and unpick their particular politics.

Cartography also dictates power based upon the formalised recognition of the discipline, casting aside other forms of spatial knowledge in favour of the accredited and accepted. Sparke (1998) illustrates the power of cartography to appropriate history, officialising it as truth based upon the principles of the powerful. He does so through investigation of the first Canadian atlas. Here the atlas represents a powerful social symbol, and the idea was that it could portray the official history of Canada. The final atlas however, removed the first peoples from the official pages of history. As a result of being behind the line of modernity, the first peoples were resembled as artefacts in ancient history and at one with the ice sheets (Sparke, 1998). Although this could be considered an issue of diplomacy between the author and the editor, the powerful social status of the atlas as a teaching tool has left the first peoples devoid of history and as a result they have become slowly eroded from common knowledge. This illustrates the power of cartography as an assumption of knowledge, which creates new version of spatial understanding shaped in the eyes of the powerful. Cartographers also have enormous power to

influence political decisions of the highest order. Campbell (1999) illustrated this by following the conflict resolution in Bosnia. He depicted a very long and arduous process of give and take, in which each side stated their claim for land. The important element was that Bosnia was to be divided both literally and metaphorically based upon nationality and ethnicity. The US military headed the reconciliation effort and the resulting map became the official claim to land. The boundaries depicted therein were to become practiced in society and eventually inscribed into its history.

2.5.6 'Democratisation' of cartography

This subsection focusses on the power of maps in creating knowledge. It draws attention to the technological developments which have opened up the field of cartography to more practitioners and explores how this has impacted on the existing power relationships. First of all, the democratisation of cartography is illustrated by tracing technological developments in order to show the opportunities, challenges and risks of mapping, before critically assessing the notion of a democratised cartography. Second, the power of maps as tools for creating knowledge is to be explored, focussing on practical examples, as well as ways in which certain truth claims are favoured and legitimised. Understanding the complex socio-political relationships between cartography and power allows us further insight into the ways in which data visualisations operate within local authorities.

The first known computerised map was completed in 1951 (Tobler, 1976) and as it received little attention, the chance of it developing a subdiscipline was viewed as overly optimistic. However, the idea reared its head again when Robinson (1976) published a series of predictions of the future leading up to the new millennium. He stated that by the year 2000, 90% of all maps would be constructed by personal computers. However, Robinson (1976), true to his cartographic perspective, suggested that no self-respecting cartographer would consider working on a computer and that computers were too rigid and inflexible ever to compete with the keen eye of a skilled cartographer, which would eventually result in an almost inevitable drop in quality (Robinson, 1976). The term, 'cybercartography' was introduced by Taylor in 2003 to define a broad scope of static and interactive web-based maps. Monmonier (2007) suggested that whilst the multidisciplinary approach of cybercartography remained impressive, it could still benefit from the design principles of traditional forms of cartography.

The democratisation of cartography, as Crampton (2006) refers to, is a movement and a change within the subject, in which access to maps and the process of map creation becomes more readily available and is no longer solely in the hands of experts. The major turning point in this movement coincided with the development of what became termed 'Web 2.0' (O'Reilly, 2004). Despite its hints towards a brand new Internet, Web 2.0 referred to a transformation of web pages away from the old static model

towards dynamic, user-generated, interactive content, placing emphasis on social media. With regards to cartography, this manifested itself through programs such as OpenStreetMap and eventually Google Maps. With the introduction of their early predecessors, such as MapQuest in 1996, cartography took its first steps towards being a more democratised field, granting easier access to a wide variety of comparable maps (Brotton, 2012).

Inspired by the success of Wikipedia, 2004 saw the beginnings of OpenStreetMap. Set up in response to tax-funded projects, it aimed to provide a volunteer GIS system (Crampton, 2006) in which participants began to work on and complete parts of the map which were yet completed, eventually offering a free and editable map of the world. OpenStreetMap has enjoyed great success, with half a million contributors registered by the end of 2011 (Neis and Zipf, 2012). It would appear that there is a great appreciation and value placed upon the ethos of OpenStreetMap. Goodchild (2007) has praised the interactive nature of OpenStreetMap and suggests that cartography is no longer in the hands of the professionals, but is now in the hands of those with actual local knowledge and understanding of the space they are working in, which can only be a benefit. That isn't to say that OpenStreetMap is not without its critics. It appears that its main strength is one of its biggest flaws. The volunteered contributions, whilst offering local knowledge and allowing free access to spatial data, are seen to lack quality control and a method of error detection. In order to improve upon these issues and continue to expand, OpenStreetMap needs to begin to build trust with its users (Geller, 2007). In this instance, democracy is achieved through the devolution of power, from the one to the many, by empowering contributors, collaborators and customers to create and share knowledge. But the cost of this is that it lacks authority and official recognition, which has limited its success. These ideas are re-established in relation to local authority data visualisation in the forthcoming analysis chapter of this thesis, in which comparisons can be drawn with local authority data practitioners.

The introduction of Google Maps and later Google Earth extended the idea of democratised cartography even further by offering free and accessible satellite images, street maps and street views. This gives users a fun and interactive world which they can discover from their computers. Google hoped that the 'pleasure of exploration' would repurpose maps into the everyday (Kingsbury, 2008). This attempted to achieve democracy by offering free, accessible and easy-to-use software, giving cartography back to the people. However, far from being a neutral gift of knowledge to the people, Google Maps is a representation of the ideals and context of its creation (MacEachren, 2004). It still shares many of the same critiques as traditional forms of cartography and GIS, such as being subjective and a product of its own social and historical context. However, these critiques are often negotiated by Google Maps by easily transferring to digital images, and from maps to satellites. This allows users to zoom far away

from the location until there is nothing but earthrise (Farman, 2007), giving the illusion of seeing everything from ‘nowhere’ (Haraway, 1999, 198). As Farman suggests, ‘photographs are often associated with a photographer’, whilst satellite and aerial photographs are ‘more commonly associated with machinery’ (Farman, 2007, 7). This is said to promote objective honesty and neutralise any human element prone to deception. These ideas echo through the current work in the field of critical data visualisation and are readdressed in the analysis within Chapter 5.

As scientific objectivity privileges the powerful, the assumed truth of Google Maps has contributed to the program becoming almost the sole access point to spatial information (Farman, 2007) and creating a digital empire (Brotton, 2012). This allows the program to shape the world in its image, monopolise fact and dictate its truths. Goodchild (2007) offers an insight into the way Google Maps participates in a global political dialogue by drawing attention to previous political border disputes and their resolutions within Google Maps. During a dispute over the Chilean border town of Villa O’Higgins, and following an intervention from the Chilean government, Google acted swiftly to restore the country’s national boundaries (Haines, 2007), highlighting the importance and authenticity placed upon maps as representations of territory and truth claims, as well as their ability to suffer from human error.

The ‘digital divide’ refers to the difference in the number of people who have access to and knowledge of information communication systems. Crampon (2006) states that there are several social characteristics which contribute to the construction of the digital divide, such as a person’s location, race and age, as well as their level of access to technology and education. With regards to Google Maps, the program has been designed with a very specific user in mind: one with broadband Internet and access to a computer with the correct graphics requirements (Farman, 2007). Whilst undoubtedly programs such as Google Maps have vastly improved access to maps and spatial knowledge for many, they have reiterated notions of Western dominance in controlling access to information, reopening debates about power control and equality on both an individual and a global scale.

One way in which Google Maps has attempted to give power back to its users is through the introduction of the Google Earth community. Using a traditional ‘map mash-up’ approach, users are able to annotate Google Maps using numerous sources of data and images in order to create a new single interface (Monmonier, 2007). Mash-ups have emerged as a relatively inexpensive way of making existing data more useful and personal, and ultimately allowing for participants’ authorship (Crampton, 2006). Within this framework, participants are encouraged to participate with one another and to share and discuss their work through the forum. The idea of empowerment has had some success within the forum,

giving the chance to empower citizen journalists and activists to share their spatial claims. But however equal and empowering the community is, it has been critiqued as being a way of enacting dominance upon its users. There are clear rules which limit and structure the ways in which it is possible to interact with the maps and each other, whilst the overlays themselves are designed by Google, prompting arguments of the 'master's tools' (Farman, 2010). This means that, although democracy and empowerment are suggested, further critical investigation is still needed. This idea is of great significance with regard to local authority visualisation, which offers notions of transparency and accountability through the public investigations of specific data sets which they have chosen to release.

2.5.7 Cartography to empower

The previous section explored the changing power relations in map production. The following section will again debate these issues, but will discuss the role of counter-mapping as a tool to empower and readdress the power relations associated with cartography. Counter-mapping is a 'uniquely late twentieth century phenomena' (Peluso, 1995, 400) and seeks to reverse the previous power dynamic. Counter-mapping operates outside the dominant hegemonic groups. This section looks into the definitions and aims of counter-maps, before looking into practical examples and how they have formed a growing following and acceptance within cartographic literature.

Created as a form of resistance against dominant power structures (Crampton, 2006), counter-mapping has become a way to question the traditional assumptions and biases associated with cartography. It empowers marginalised groups by representing them spatially through official and authentic means, and with equal skills, knowledge and technical nous as elitist groups (Dalton and Deese, 2012). By acting on behalf of alienated groups, cartographers are able to legitimise their claims to space, officialise their history and reflect upon alternative truths which may have been left unheard. Peluso (1995) coined the phrase 'counter-map' during her work on indigenous forest territories and conflicting claims for land between the forestry commission and the indigenous people. The former utilised expensively acquired land-use maps as a tool for officialising its own claim, whilst the indigenous people relied on various oral histories. Peluso (1995) argues that whilst mapping offers access to the tools of the powerful, it also reduces customary law to a moment in time, therefore relieving the dynamic social processes of their flexibility. This is a point which was similarly portrayed by Sparke (1998), whose work depicts a trial and the problems the First Nations had in getting their own customary laws and knowledge accepted and realised within the Canadian legal system. Similarly, Brown and Knopp (2008) worked towards legitimising a claim to space by providing a historical account of Seattle's gay and lesbian community. The important context for this study is that it pre-dates the Stonewall riots, a time of prominent homophobia. There were very few establishments in which gay people were welcome,

which meant that queer space retreated into the closet and was reduced to invisible worlds, temporarily hidden. The final map staked a claim for the community by moving away from exile into belonging.

Both Brown and Knopp (2008) and Peluso (1995) revealed problems in accurately reflecting multiple intertwining social, political contexts which were played out through lived experiences onto two-dimensional maps. Whilst ethically counter-mapping can be used to empower and legitimise the marginalised, both maps were subject to conflicting truths. Brown and Knopp (2008) declared that the inclusion of certain knowledge often rejected the possibility of others. Although, the previous section illustrated the relationship between cartography and power, it did so from an opposing viewpoint. In these instances, alienated and excluded social groups used their ‘master’s tools’ in order to stake their own claims to land. The idea of representing marginalised groups through ‘official’ means often leads claim to authenticating their position and adding value role within society.

2.6 Post-representational cartography

Following the critical turn in cartography, more recent developments have led to fundamental changes in the ways in which maps are understood and used (Caquard, 2015), reconceptualising maps as emergent practices. This subsection presents a chronological account of developments in post-representational cartography. It accounts for the theoretical progress and methodological benefits associated with a post-representational approach, before drawing attention to the key literature which forms the basis of the forthcoming analysis chapters of this thesis.

Del Casino and Hanna (2000) took the first steps toward a post-representational cartography in their work with tourism maps. They argued that the ‘moment of map production is not determinant’ (p.24). They illustrate that maps, identities and spaces are co-created in particular contexts and as such mappings are never fixed. This is a point which is echoed by Crampton (2003), who suggests that to develop understandings of maps, we must consider the historic and geographical conditions which shape map creation and map use. Pickles (2004) sought to reinterpret maps as moving from ‘readerly’ to ‘writerly’ texts, in which the reader is in part a co-author of the text, producing a multiple and open series of readings dependent on the user’s knowledge, interests and abilities. This notion of the reader as authoring their own meaning is specifically applied to local authority data visualisation in section 5.2.

Del Casino and Hanna (2006) again make the case for a processual interpretation of maps. Through investigation of tourism in the city of Fredericksburg, they draw attention to the role of 'alternative narratives', in this case the tour guide, who inscribes value and adds meaning to tourists' experiences of the city, co-creating the map through a mix of production and consumption, authoring and reading, representation and practice. Kitchin and Dodge (2007) further this by challenging the ontological security of maps. They argue that, to move from a representational to a processual approach, we must consider maps as ontogenetic, of the moment and brought into being and made to do work in the world. Maps should be considered as being 'constantly in a state of becoming' (Kitchin and Dodge, 2007, 335), never fully formed; their work is never complete. As such, they are always mappings, spatial practices enacted to solve relational problems (e.g. how to get from A to B). Their work also highlights the ways in which an ontogenetic position can benefit cartography. They suggest that it democratises cartography by recasting it from a professional discipline to a spatial science. It recognises the diverse effects that mappings have in the world, which go beyond analysis of power and politics; it presents a broad practice for both theoretical and practical developments to co-exist, and ultimately it better reflects how life unfolds around us. The complex engagement of methodological and analytical practices highlights the contested and collaborative ways in which maps unfold. Kitchin et al (2012) revisit their work and argue that mappings do not appear and emerge in the same way for all individuals. Rather they unfold in context through a mix of processes and are affected by the knowledge, experience and skill of the individual to perform mappings and apply them in the world. This approach recasts cartography as a broad set of practices, to think critically about the practices of cartography and not simply focus on the end product. To consider cartography in this way could provide a common framework both for those seeking applied knowledge (asking technical questions) and those who seek to ask ideological questions. More recently, Gerlach (2014) recognises maps as emerging through process and performance and producing their own micro-politics. This has been outlined as an issue currently within the field of data visualisation and, as such, a post-representational cartography can offer a space for both the practical and theoretical aspects to cross-pollinate.

As a methodological approach, post-representational cartography presents a number of challenges to capturing the intertextual, multivocal nature of mappings. In their work, Brown and Knopp (2008) present a version of the mapping practice before it unfolds in their historical account of Seattle's gay and lesbian community. They reveal the productive tensions present in reflecting multiple intertwining social, political contexts on a two-dimensional map, and question the role of memory and trust in their data reliability. This presents tensions in production, debating how to define the significance of spaces and whose significant spaces to represent. Challenges also arise when trying to represent the 'connectivity, fluidity, multiplicity, and multiple scales when making a simple two-dimensional map' (Brown and Knopp, 2008, 50). Kitchin (2012) also gives a processual account of how mappings emerge

when depicting the mapping of Ireland's ghost estates. The work traces the complex, messy and negotiated practices of map construction which evolved over the course of the research. Kitchin (2012) illustrates how the map, working in the world through its genealogy, has shaped public debate and public policy, being covered directly 300 times in national and international media. More recently, Swords and Jeffries (2015) have drawn attention to the complex methodological practices of representing the unrepresentable in their account of tracing the skate worlds of Newcastle upon Tyne, UK. In their work, they illustrate how skateboarders became a part of the map-making practice, and that their mappings became part of a more significant interplay of performance, identity, visualisation and exhibition (Swords and Jeffries, 2012).

I would now like to draw attention back to the work of Kitchin (2012) and present the framework for this research as it applies to a post-representational cartographic approach to help understand local authority data visualisations. Kitchin suggests that maps are '(re) made in diverse ways (*technically, socially, bodily, aesthetically and politically*) by people within particular context and cultures as solutions to everyday tasks' (Kitchin, 2012, 480).

In their work, Kitchin and Dodge (2007) highlight a post-representational cartography as being able to unpick how maps 'become' – how they are beckoned into being and made to do work in the world. This research engages with this idea of 'becoming' to illustrate the complex interaction of processes which action data visualisations into being, as they are unfolded more in keeping with how life unfolds in the day to day (Kitchin, 2012). This approach is to be unpicked and mobilised as the primary framework for investigation in the following chapters of this thesis. The five key cartographic processes as identified by Kitchin (2012) are to be adopted and recast over local authority data visualisation in order to untangle the role of the complex constellation of actors, intermediaries, organisations and contexts in the unfolding practice of data visualisation.

2.7 Summary

The first section of this chapter explored the challenges of interpreting large amounts of data and provided critiques of the objective connotations of data. One proposed solution to the challenges presented by data has come through visualisation. Section 2.3 discussed data visualisation through an account of the historical works and literature. It also illustrated a lack of theoretical or philosophical engagement with the discipline. The reasons for this are twofold: the main practitioners and operatives within the field of data visualisation are not academics, and therefore there economic transaction with

the field is reliant on production; and the literature is concerned with generating design conventions which operate as a professional watermark for the application of data visualisation (Kirk, 2016; Kennedy, 2017). The academic application of the field stems from computer science and graphic perspectives, which are concerned with presenting data as efficiently and effectively as possible (Few, 2004). Therefore, the theoretical and philosophical exploration of the subject continues to be neglected.

Section 2.4 presented a chronological account of cartography. Attention was drawn to the multiple similarities to and overlapping theoretical developments in the field of data visualisation. Early work in cartography was focussed on the models of communication (Morrison, 1976) and functionality (Robinson, 1976), which can be compared to the contemporary field of data visualisation. The critical turn in cartography began to deconstruct maps in order to reveal their hidden power dynamics. By deconstructing maps, scholars were able to build a new theoretical background of cartography, which placed each map in its own historical and social context and reflected the ideals of those who created it (Harley, 1989). Most recently, scholars have sought to shift cartography from being a representative to a processual science, considering maps as ontogenetic, of the moment and brought into being and made to do work in the world (Kitchin, 2007).

Therefore, this research proposes to apply the theoretical developments from cartography – a field which shares similarities with data visualisation, but which has a more mature and richer history of philosophical questioning and theoretical debate – to data visualisation, in order to fill the gaps outlined in this chapter. A post-representational cartography could provide a common framework both for those seeking applied knowledge (asking technical questions) and those seeking to ask ideological questions (Kitchin, 2012). Through its application, this research explores what can be learned by interpreting local authority data visualisation through a post-representational cartographic lens.

3: Methodology

The previous chapters have provided a background to this study and highlighted the conceptual framework mobilised to answer the research questions:

1. *How and why do local authorities use data visualization?*
2. *How do visualizations 'become'?*
3. *How useful is post-representational cartography to understanding data visualization?*

It is necessary to make strategic choices about which methods are best suited to answer the research questions. Mason (2002) defines research design as a strategy which applies a 'logical' framework in order to achieve the specified research aims. In developing appropriate methods, this research explores and adopts an existing body of literature, in order to set out the epistemology and mixed methods approach.

The difference in methodology and the applied methods must also be noted. Methodology refers to the study of methods, their philosophical implications and epistemological foundations. Methods are the chosen techniques and empirical materials which are enacted to enable the exploration of the research aims.

3.1 Justification of theoretical approach

Before engaging with the adopted methodological approaches, it is important to first refresh our understanding of the nature of researching data visualisation and the theoretical justification for the chosen methods. The nature of data visualisation as a discipline is still primarily focussed on areas of best practice, to increase the efficiency of recognition and ensure audience engagement. As such, there is an absence of theoretical grounding. Often this has meant, in the creation of a visualisation, that the outcome reflects the academic grounding, principles and perspective of its creator. This has led to a fractured and splintered field influenced by a variety of cross-pollinating academic fields.

This has presented both challenges and opportunities for researching data visualisation in its current guise. Because of the complex, sprawling interdisciplinary nature of data visualisation, this research will align itself with the work of Benneworth and Henry (2004) in adopting a position of 'hermeneutic theorising'. This epistemological position utilises an interpretive, reflexive and open-ended mode of

enquiry that recognises the diversity of available sources and encourages discussion across a wide range of overlapping and competing perspectives. This will therefore be inclusive to the many perspectives of data visualisation outlined in the previous chapter and will allow freedom for this research to delve into academic avenues which may have otherwise been sealed.

This research also mobilises recent theoretical developments in cartography to investigate what can be learned from applying a post-representational cartography approach to local authority data visualisation. A post-representational cartography seeks to radically alter how we understand the ways in which maps are made and used (Caquard, 2014). Kitchin and Dodge (2007) suggest that it's productive to think of maps beyond representations and instead to consider them as ontogenetic in nature. That is to say, maps do not exist until something is recognised and/or used as a map, moving the focus in much of critical cartography from what maps are to how things 'become'. This approach conceptualises maps as being (re)made through technical, social, embodied, aesthetic and political processes by people within particular contexts and cultures (Kitchin, 2012). This approach offers numerous benefits to cartography which can be translated into research on data visualisation. The benefits of adopting a post-representational lens is that it creates a theoretical space which encompasses both those asking technical questions and those seeking to challenge theoretical assumptions (Kitchin and Dodge, 2007). It also provides a way to think critically about the practices of cartography and how they are actioned to work in the world, and not simply the end product.

In researching cartography, Crampton (2003) suggests that there must be an ontological examination of maps and mapping to investigate the historically and geographically contingent conditions which shape map creation and use. Kitchin (2012b) goes further, noting that post-representational cartography should explore the constellation of actors and their interactions that shape the unfolding. This includes knowledges (existing artefacts, manuals and guides), practices (aesthetic choices, conventions) immaterialities (equipment, software, paper, pens) and the organisations themselves. Therefore, this research seeks to interpret a holistic account of the unfolding practices of data visualisation. By mobilising the work of Crampton (2003) and Kitchin (2012b), it applies its gaze not solely to the visualisations themselves, but to the actors, interactions, organisations, knowledges, practices and contingent conditions which beckon data visualisations into being.

The rest of this chapter explains how the research questions have been enacted to produce the findings which make up the resulting chapters of this thesis. With this in mind, the following chapter justifies the chosen methods and adopted approach. It begins by outlining the methodological grounding in social science and some of the critiques levelled at the chosen approaches.

The following section (3.2) explores the mixed methods approach adopted by this research project. Section 3.3 focusses on research design, looking into social science research methods more broadly to highlight the benefits and critiques levelled at the chosen mixed methods approach, before focussing on survey and case study as the chosen methods of data collection. Here, again, I note some of the critiques and how their influence was mediated. Section 3.4 explains the research methods I adopted to enact the first phase of data collection, describing the processes, techniques and challenges faced during survey distribution and data collection, as well as my own reflections on the events. Section 3.5 again focusses on research methods, this time examining the case studies and interview process. It notes how participants were targeted and which interview techniques were implemented, and concludes by reflecting on how the interviews can collectively form the basis for case studies. Finally, section 3.6 focusses on my personal reflections from the data collection process.

3.2 Mixed methods

A mixed methods approach can often represent a philosophical and methodological middle ground – a position which emphasises a practical and outcome-oriented approach to investigating the research aims (Onweugbuzie and Johnson, 2004).

Quantitative research methods develop factual knowledge, gaining statistical insights into patterns and the relationship between factors. In this instance, the quantitative data is to be collected through a survey questionnaire, which benefits from being replicable in numerous settings and producing comparable data (Karlsson, 2015). Conversely, qualitative data focusses on subjective experience and the context derived from people, interactions and the situational working environment, offering on reading a deeper understanding of the events (Flowerdew, 2013). As such, qualitative methods will be used to give depth of insight into the chosen case studies (Hay, 2016).

This project seeks to investigate working experiences and the production processes involved in local authority data visualisation. In order to support the research aims, the initial data collection had to therefore come directly from the local authority participants in the form of a survey questionnaire. This allowed me to interrogate key factors, trends and general ways of working. This research then facilitated a deeper, context-specific understanding of individual local authority organisations through case studies. This included utilising in-depth interviews in order to interrogate the opinions, views and concerns of individuals who play a role in the production and practice of data visualisation, while simultaneously highlighting its complexity and the multiplicity of actors involved.

Whilst a mixed method approach has become more prominent in social science, it has been considered to be theoretically suspect (Armaratunga, 2002). Despite this, it benefits from the positive aspects of each of the chosen methods of data collection (Charles and Tashakkori, 2009). This is a point emphasised by Creswell (2008), who suggests that both approaches can complement each other, which can ultimately give great value to research that investigates phenomena on different scales. Harmony between the two points of view remains key, and both methods should be viewed as two points on the same continuum, rather than opposing, conflicting philosophical frameworks (Creswell, 2009)

3.3 Research design

3.3.1. Survey questionnaire

Despite a burgeoning understanding that quantitative and qualitative approaches can co-exist, they remain subject to the collective critiques of each individual approach. Traditional paper postal questionnaires have been critiqued for being time-consuming and costly (Byram, 1984). However, this problem has been negated by conducting the questionnaires online. Other critiques of questionnaires focus upon design. The selection of clear and effective questions is considered integral to reducing the influence of the researcher (Fowler, 2002), whilst Kallus (2001) states that the major shortcoming of the questionnaire is that the participant can be subjected to, and influenced by, social norms, which leads to a misrepresented population in the data set.

Case study

The case study approach has long been associated with the social sciences, although there has historically been an opposition to the usefulness of this method. Case studies have been perceived as lacking the necessary scientific rigour, which results in an absence of control (Campbell and Stanley, 1966). Others have critiqued the subjective nature of the method, which lends itself to very context-specific outcomes that are not generalisable, as they reflect phenomena in a specific time and place (Flyvbjerg, 2006; Wisker, 2008). This means they can be difficult to summarise into neat scientific formulae, propositions and theories (White, 1990). One potential solution, as noted by Ragin (1992), is that generalisability can be increased through strategic selection of cases. This critique often fails to grasp the point of case studies. According to Flyvbjerg (2006), case studies are best read in their entirety as a complete narrative. Their value is somewhat lost when diminishing the importance of their contextual nature (Peattie, 2001). The ability to represent phenomena in a specific context is incredibly important for understanding why organisations work as they do. Adopting a case study approach allows for an investigation into the significance of various circumstances, such as size, budget or location (Flyvbjerg, 2006), whilst obtaining insights into micro-level social processes which would otherwise remain hidden (Swanborn, 2010).

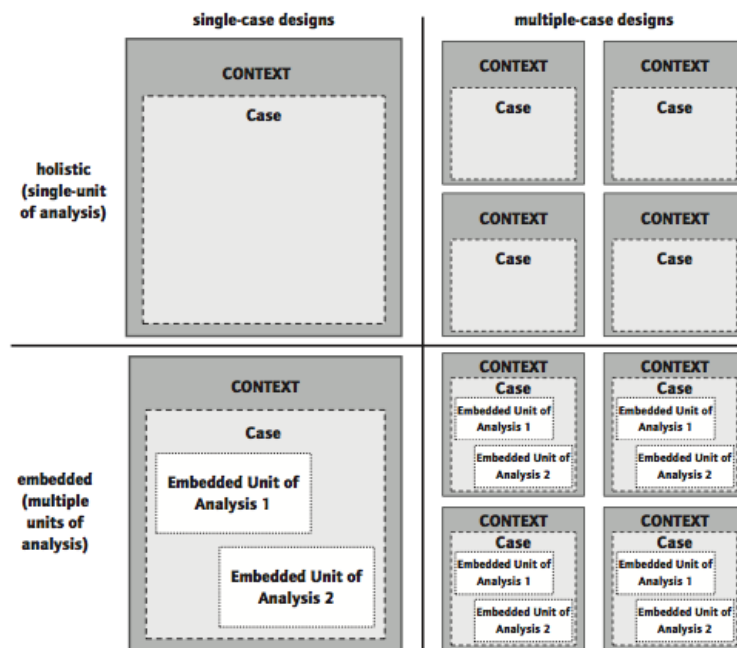
Kidder and Judd (1996) identify four design considerations to help maintain case study validity. The figure below has been adapted from a more general social science approach. It illustrates which phase of case study research can mobilise each aspect of validity. Each of the four tests has a set of tactics available for checking case study quality, although not all the tactics occur in the formal stage of designing a case study. Some occur during the data collection, data analysis or compositional phases of the research.

Table 3.1. Designs of case study validity (Kidder and Judd, 1996).

Tests	Case study tactic	Phase of research in which tactic occurs
Construct Validity	<ul style="list-style-type: none"> • Use multiple sources of evidence • Establish chain of evidence • Have key informants review draft reports 	Data collection Data collection Composition
Internal Validity	<ul style="list-style-type: none"> • Do pattern matching • Do explanation building • Address rival explanations • Use logic models 	Data analysis Data analysis Data analysis Data analysis
External Validity	<ul style="list-style-type: none"> • Use theory in single case studies • Use replication logic in multiple case studies 	Research design Research design
Reliability	<ul style="list-style-type: none"> • Use case study protocol • Develop case study database 	Data collection Data collection

As Gerring and Swanborn (2010) note, there is more than one way to build a house, and case study design is much the same. The table below presents the possibilities based on a 2x2 matrix.

Figure 3.1. Single and multiple case study design (Source: Yin, 2003).



The nature of the research – investigating local authority processes – lends itself to incorporating a holistic multiple-case design approach. One major critique of the multiple case study method is the comparatively extensive resources and time taken, which is usually beyond the means of a single independent research investigator (Yin, 2003). Although where possible, the evidence provided by a multiple-case design is considered more compelling and, therefore, the research more robust (Herriot and Firestone, 1983). In studies observing the various circumstances of case process, it is necessary to obtain information from multiple cases that remain different in one or more dimensions (Flyvbjerg, 2006). The context in which processes exist within each case is something, which resonates deeply with local authorities. This forms the basis of the empirical findings and analysis in Chapters 4 and 5.

3.4 Research methods: Survey

The initial steps taken in data collection began with an exploratory scoping exercise using a survey questionnaire. The aim was to understand the complex structures, economies and operational practices within local authorities and the differences between local authorities on a national scale. This phase of research accounted for two main uses. The first is to provide an understanding of the ways of working in local authorities. This contributes partially to the first research question – ‘How and why do local authorities use data visualisation?’ – whilst also informing the framework for case study selection and eventually the themes of the interviews. The following section outlines the journey through survey

development, participant selection and how the responses were mobilised to inform case study selection.

3.4.1. Sample design

One of the main issues in understanding the differences between local authorities is that they remain extremely varied in terms of numerous indicators. They are not uniform in location, size of workforce or operational ways of working. As such, it remains difficult to identify local authorities which are representative and indicative of a certain model.

4.3.2. Sample size

As stated previously, local authority priorities and ways of working differ greatly on both a local and national scale. In order to utilise the survey as a means of gaining a broad understanding of these differences, a total population sample was taken. This gave a more holistic understanding of the differences and identified trends, similarities and key factors in local authority structure, operations and culture of data visualisations.

This meant distributing a survey to each of the 326 local authorities in England. Therefore, a database with a potential contact from each local authority was collated. It included potential participants who were viewed as being in a position to give an insight into data visualisation. This meant those credited with curating reports, those linked with data hubs and those working in insight and performance teams. Although the process was extremely laborious, it did offer benefits, as it provided an insight into which departments are most likely to be responsible for data visualisations. It simultaneously allowed for the development of a portfolio of the methods, locations, formats, data and data visualisations that had been published publicly.

3.4.2. Sample procedure

For the process of creating a database, a few methods were adopted for negotiating, at times, very problematic local authority websites. Contact information and departmental information was extremely difficult to source. By using multiple techniques, it became possible to ensure that the participant at point of contact would be informed enough about my research to participate or to identify a more suitable participant.

The first method involved investigating the organisation's website and social media to try and find data visualisations. This proved useful, as it documented the types of data visualisations being produced and

released to the public, whilst also attaching a name or department responsible for its creation, which then became an initial point of contact.

Throughout this process, several reoccurring themes emerged, such as departments for innovation, performance and insight being responsible for data visualisation. In the instances where there was no evidence of data visualisation, attempts were made to identify the correct department by searching these keywords. On numerous occasions, this provided a general line of enquiry to that department and was therefore beneficial.

The third layer of investigation was to telephone local authorities. This was beneficial due the immediacy of the response. It also allowed for a conversation with participants and an opportunity to explain the research. By being present to answer questions posed by the local authority, it became possible to better navigate the research towards the correct team and department, and reduced the risk of contacting the wrong person. However, some conversations would end in receiving a contact email address which, on at least one occasion, became a long chain of forwarded messages to other members of staff. In one example, this led to three staff members contacting me to state that they were happy to be the point of contact. Although positive, it slowed the process of clarifying who would be best suited to the eventual data collection.

Another drawback of telephoning was that some services were automated for residents to be able to apply for permits, pay bills and report issues. This meant that it became impossible speak to potential participants. In these instances, and as a last resort, emails were sent to the general enquiry address, containing some background information about the research and myself, and asking for the contact information of a suitable person or department. On all of these occasions, the automatic response indicated an estimated length of time in which it would take for a response to be generated. When this time limit had passed, contact with the local authority was again re-established, this time through a similar message to their social media account, which in some cases was monitored on a more regular basis.

3.4.3. Survey design

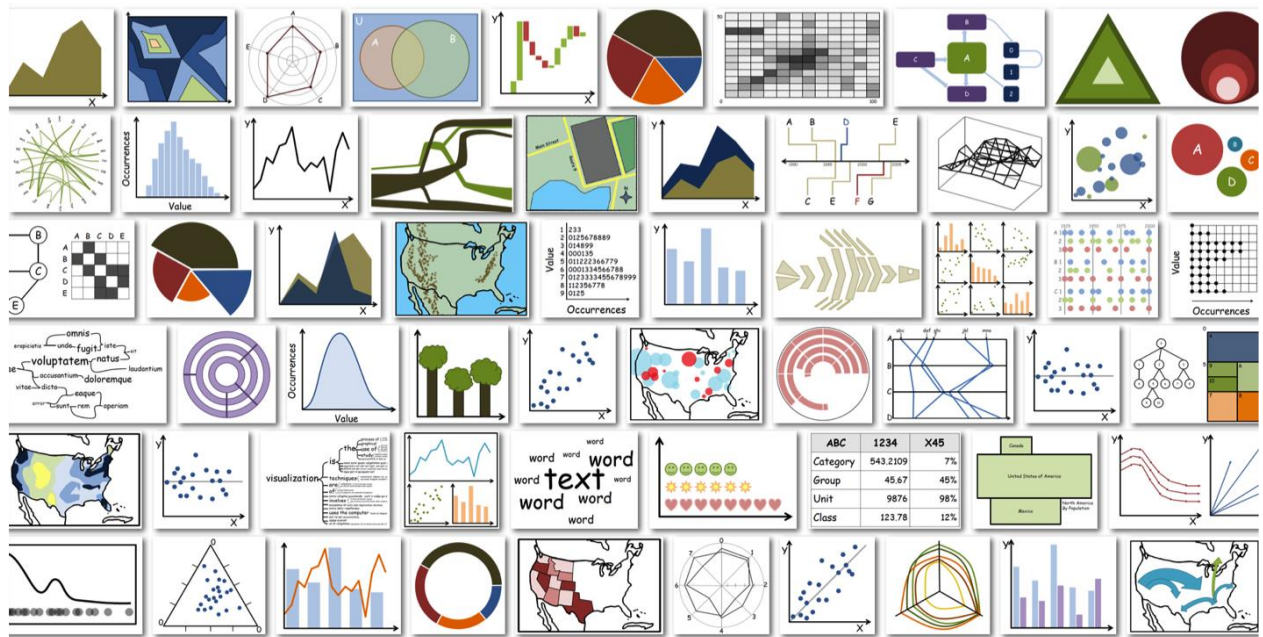
As mentioned in the previous section (3.3), the intention of the survey was to help collate a broad understanding of how local authorities use data and data visualisation. This helps to inform and compare the differences, similarities and influential factors on a national scale. Despite having made contact with local authorities when sourcing the participant database, the survey was a chance to reintroduce the research project. The opening page was headed with the logo from Northumbria University, along with the relevant contact information and a paragraph outlining the research aims. This served two purposes:

to authenticate my own position as a researcher, which it was hoped would increase response rates, and to again inform the participants about the research, in the hope that this would direct the survey towards the most suitable candidate. The ethical procedures and codes of conduct were also displayed on the cover page, informing the participants of issues such as the right to withdraw and the process of anonymity.

The survey design and question selection focussed on two key areas: the specifics regarding the local authority structure, and the data visualisation production processes. Following the guidelines outlined by Byram (1989), the survey began with questions of a more general nature, intended to make the participants feel more at ease and to set the tone. The questions would gradually become more in-depth and data-visualisation specific.

In order to glean as much information as possible from each respondent, and to best ensure that participation was maintained until the end of the survey, the process and question structure was streamlined to be as efficient as possible. As such, information which could be found online was removed from the final version of the survey. A mix of question types was included in order to help maintain interest in the often laborious process of completing a survey (Wisker, 2008). For example, an in-depth list of data visualisation types was used in a 'tick all that apply' question, as opposed to leaving the question open for participants to list all visualisation types. This meant that participants could quickly negotiate the list, providing as much information as possible. Conversely, other questions were much simpler in design, such as, 'Have you ever worked alongside partner organisations?' where just a yes or no was required.

Figure 3.2. Selection of chart types used in the survey.



3.4.4. Survey distribution

Once the design was complete, the distribution process began. An example definition of the term ‘data visualisation’ was given, as was an insight into what to expect from the survey itself, including, for example, the estimated time that it would take, to improve the response rate. Finally, there was an explanation of how to access the survey with the provided link. A copy of the participant information form and the survey can be found in appendix B.

3.4.5. Time frame

The actual process of distributing the questionnaire took a number of weeks in total. Due to the number of participants, it was decided to stagger the distribution of the surveys to help maintain control of any correspondence. This allowed enough time to communicate with potential participants, respond to queries about the research and in some cases reaffirm the ethical guidelines.

3.4.6. Survey responses

Despite efforts to target the correct person, several respondents forwarded the email internally to other respondents. Interestingly, four respondents answered for multiple local authorities that share a data visualisation team. The majority of responses came back within seven to ten days. Reminders were sent out three weeks from the initial sending date. In total, I received 81 responses, which equaled a response rate of 25%.

3.5 Research methods: Case study

The main method of case study development was interviewing participant and additional analysis of data visualisation. The following section depicts the interview process, detailing how participants were selected, before reflecting on the interview process.

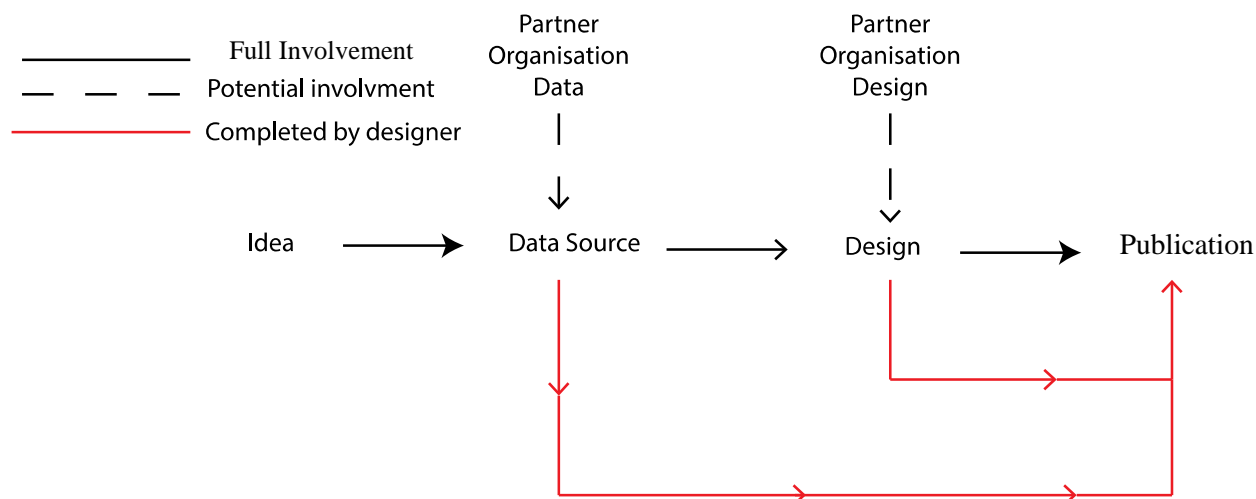
3.5.1 Case study framework

Strategic selection is the fundamental task in choosing cases, as it sets the agenda for the research (Seawright and Gerring, 2008). In trying to understand how local authorities engage with data visualisation, it is important to gain an insight into how the processes can be shaped by the geography of each organisation. The size of an authority and its population are potentially important, as they have a direct influence upon service delivery, resources and number of staff. The location can also inform numerous influential factors such as demography, economic context and the priorities and goals of local authorities and their citizens.

With this in mind, there is also a wide range of operational procedures within local authorities that influence the practice of data visualisation. These can differ between authorities and are less related to the institutional characteristics addressed in the above paragraph. They are more a product of the specific staff, skills, leadership decisions, organisations and practices of each specific working environment.

The figure below has been informed by data gathered from surveys. It illustrates the multiple pathways of data visualisation creation in local authorities. The black flow represents the completion of the entire process from data sourcing to publication. However, some actors will only be present at certain moments. The actors can more generally be split between designers (data visualisation experts) and organisers (managers, team leaders and front-line staff)

Figure 3.3. Production flow chart of local authority data visualisation.



As a result, the following case study framework has been created in order to ensure that the most informative case studies have been chosen.

Criterion 1: All case studies should exist within Figure 3.3.

The intention of each case study is to give an in-depth understanding of a particular way of working adopted by local authorities. While each case study highlights one particular process, collectively they illustrate production processes on a national scale.

Criterion 2: Together, all case studies should aim to give a representation of the contexts in which local authorities engage with data visualisation.

Local authorities are working in challenging environments and are required to maintain high standards of service delivery, transparency and public consultation. Each case study provides a different perspective, and collectively they highlight the varying operational uses of contexts in which data visualisations are practiced within local authorities.

Criterion 3: Case studies are chosen due to their high output of data visualisations.

This criterion is self-explanatory, but it is necessary when understanding how data visualisations emerge in different contexts that each case study will be actively engaging with data visualisation.

Criterion 4: Individual case studies must highlight differing maturities of engagement.

This refers to the skill and complexity of the typography of data visualisations. Although all case studies must have a high output, as mentioned above, the case studies must be representative of all abilities, resources, aims and outcomes regarding data visualisation.

Criterion 5: Case studies should show a willingness to engage, and be able to provide access to a wide range of actors across the production pathway.

This criterion is a necessity of researching and of the time constraints associated with completing a PhD. All cases must be able to provide access to a range of actors in order to interpret data visualisations post-representationally.

The first criterion draws on the survey results and aims to incorporate the three key pathways of the production of data visualisation. It aims to cover the different ways in which the production of data visualisation in the organisations can be delegated and shared across numerous actors, taking into consideration those who take on the whole process, and organisations that split tasks between data gathering, analysis and communication. It also aims to include examples of organisations that work with partner organisations, freelancers and outsource their data visualisation engagement.

The second criterion aims to cover a variety of the differences between local authorities, in order to highlight which factors influence the emergent qualities of data visualisation. The cases should cover a mix of large and smaller areas, and urban and rural environments. It is also inclusive to cover unitary, metropolitan and non-metropolitan councils. The case studies should also aim to cover a range of factors regarding affluence and deprivation. This is interpreted by the score on the Index of Multiple Deprivation, which ranks areas from most to least deprived. The ranking is weighted across the following indicators:

- Income deprivation (22.5%)
- Employment deprivation (22.5%)
- Education, skills and training deprivation (13.5%)
- Health deprivation and disability (13.5%)
- Crime (9.3%)
- Barriers to housing and services (9.5%)
- Living environment deprivation (9.2%)

Whilst recognising that there is a huge scope for difference in the economic and social challenges facing each individual authority, this research aims to portray a range of examples of the types of socio-economic factors facing authorities throughout England. Including a range of levels of deprivation will

highlight the challenges facing each of the case study authorities as dictated by the needs of the local population. This will also help to identify whether geographical change is significant in the unfolding practices of data visualisation.

The third criterion confirms that all cases will have considerable output in terms of engagement with data visualisation. In the fourth criterion, different maturities of engagement are included. This aims to cover three different approaches to data visualisation – the scientific, graphic and design-based approaches – and a more contemporary data visualisation-specific approach. This is important as it reflects the type of software the organisations are engaging with. Including a range of aesthetic complexities in design will help to reveal a number of other key processes. It will uncover the way in which the potential audience influences design, the ambitions and creative freedom of the designer, as well as a number of key logistical practices, such as the time spent on projects.

Implementing these four criteria highlighted six potential case study organisations. Potential case study 5 was a small population local authority case, which worked primarily from a data visualisation approach (as opposed to graphics or computer science). However, two issues prevented this case from being selected. First, whilst it shared similarities with case study 3, it did not have the advantage of operating with any external partners or neighbouring organisations, which can provide a different dynamic to the unfolding of data visualisation. Second, there were issues of logistics and access, which meant that it became increasingly difficult to get permission to conduct research within the authority.

A further potential case study organisation (case study 6) was a large urban area housing a large population. This organisation met the criteria outlined above and was initially considered. It shared similarities with the selected case study 4 in terms of approaches to data visualisation and maturity. However, as noted in the following section, case study 4 also had a specific research and governance panel which disseminated data-based training and operated as an overseeing panel on issues of research and data quality. Therefore, the opportunity to investigate these particular networks – as well as more issues of access – meant that case study 6 was removed.

3.5.2. Selected cases

Although this research focusses on the engagement of local authorities with data visualisation, it does not focus on guidelines of best practice. Rather, it presents a theoretical exploration of the processes through which data visualisations emerge. In recognising that these processes are (re)made individually, it seeks to present a theoretical discussion which considers data visualisation from a post-representational cartographic perspective. In doing so, it presents an account of the unfolding processes of data visualisation as they emerge in practice. In order to best investigate the effects of these processes on the individual, and to encourage openness with participants with regards to their working

environments and workplaces, it was necessary to anonymise participants and organisations. Many participants faced issues of job sensitivity. Those employed within the data visualisation teams are doing work which could be construed as replacing further existing staff if done successfully, whilst other staff have seen their working roles radically altered with the inclusion of data visualisations. Furthermore, all the participants were under constant pressures of job security as a result of the larger cuts to funding. Therefore, the name of each local authority was replaced by a pseudonym, which intended to create a space in which participants could openly and honestly discuss their work colleagues, their organisations and their feelings towards these shifting roles. The following cases were chosen:

- Authority 1
- Authority 2
- Authority 3
- Authority 4

(Case studies will be discussed in depth in Chapter 4.)

3.5.3. Interview sample design

The use of the semi-structured interview allowed for flexibility within the interview so that new avenues could be followed. It provided an opportunity for participants to concentrate on issues they felt most strongly about, whilst maintaining some structure to the interview through an interactive dialogue (Schoenberger, 1991). The semi-structured interview also allowed participants to address the individuality of their experience and their engagement with data visualisation, which is key to a post-representational approach.

In order to tease out the complex unfolding practices of data visualisation when considered from a post-representational perspective, interviewing different actors from within different parts of the organisation allowed me to gain multiple perspectives on the same phenomena as they played out (Lilleker, 2003). Speaking to numerous actors from different hierarchical positions also allowed me to gain further insight into the role of the organisation and the politics involved, as data visualisations are created within multiple competing contexts which are unfolding simultaneously.

The interview participants could be split into two categories. First, those working at the selected local authority case studies, as outlined in the previous subsection. This included a mix of designers, line managers, graphic designers, and data specialists and communications officers. Second, those considered to be experts and active members of the data visualisation community. For this, three ways

in which people could be categorised as ‘active’ members of the data visualisation community were identified:

- They contribute to the growth of knowledge, skills and expertise by hosting workshops and seminars.
- They provoke critical discussion in blog posts, forums and podcasts.
- They promote the development of the academic side of the subject by publishing papers and attending conferences.

3.5.4. Interview sample procedure

Selecting interview participants for the case studies was fairly straightforward, as previous contact with participants at the local authorities had been established by researching the work done at that local authority and the survey data. It became possible to identify potential participants through the roles and operational processes within the organisation. For those not identified, snowballing became a good way to find interviewees. Participants had a far better understanding of the case study organisations and, as such, could make more informed choices as to potential key contacts.

Identifying the second type of interviewees (the experts) was somewhat more difficult, as data visualisation publications in academic journals are somewhat fledgling. Literature on the subject and critical discussion are often played out in more instantaneous settings, such as blog posts, social media and podcasts. Therefore, building up an understanding of the wider network of the data visualisation community meant that it became possible to identify more prolific or influential actors. Again, snowballing became useful in identifying participants who contributed to data visualisation debates, published data visualisations, hosted workshops, conducted seminars and regularly contributed blog posts. Also, the algorithmic ‘who to follow’ recommendations on social media became helpful. However, algorithms must be considered critically in the way they construct, reinforce and perpetuate the same viewpoint and knowledge (Amoore, 2016). Looking more closely at a blog post, it is important to consider that the content is primarily opinion-based, and in many cases blogs are musings on a wide range of subjects designed to provoke discussion or to act as a starting point for research to develop (Rose, 2014). There are also issues of reliability and authenticity, which are negotiated by cross-referencing and triangulating the work of participants with other members of the community, and by examining the work history of the participant.

It must also be understood that the Internet only provides an insight into the community of data visualisation experts who have a strong social media or Internet presence. It therefore must not be considered in isolation. However, due to the nature of the subject and how embedded its routes are

within technology and the digital environment, using this approach seemed the most prosperous solution.

3.5.5. Interview preparation

Preparation differed depending on the organisation and the role of the interviewee. The information gained in the previous stage of research and the case study framework helped to inform the content and structure of the questions. Semi-structured interviews were used with the intention of providing enough structure to cover the necessary aims, whilst maintaining enough flexibility to allow the participants to explore any avenues they found most interesting.

Initial contact was made by emailing the participants. It is suggested by Yin (2003) that during initial contact it is important to highlight your own research, clarify why you have contacted the participant and give an insight into the types of questions they are likely to face. All emails were sent from my university account to help make official my association with Northumbria University, therefore adding legitimacy to my own position as a researcher.

When arranging the interviews, I remained as flexible and adaptable as possible. Interviews were always offered at a time and place chosen by the participant, with Skype and telephone interviews provided as an alternative to meeting face to face. This meant that I was able to conduct interviews with data visualisation experts in other countries, although the time difference often meant that I had to work late into the evening. This approach aimed to increase participation, as local authority staff are already working under severe time constraints. It also attempted to make the interviewees feel as at ease as possible, in order to reduce any feelings of being in an alien situation, and as a result to minimise the effects of any unequal power dynamics.

3.5.6. Interview procedure

Many participants favoured Skype interviews over meeting face to face. Retrospectively, I found that participants felt they wouldn't be able to meaningfully contribute to the research and decided against arranging a face-to-face interview in order to 'save you the hassle' (Participant 4B, Midlands Authority). The experts also preferred Skype for interviews. In some cases, this was due to the impossibility of a trans-Atlantic field visit. However, in most cases it was due to the participants being freelance, which meant that they were frequently traveling and working on several projects simultaneously, without regular office hours or office space. However, this also provided other opportunities – by accommodating interviews outside of the usual working hours, it meant that I was able to conduct interviews with all the targeted participants.

The interviews began with an introduction and a reminder of the ethical procedures. Then I started with a series of background questions. This was a strategy employed to facilitate conversation with something familiar to the interviewees, allowing them enough freedom to move between subjects and themes with as much fluidity as possible. All of the interviews were recorded on a Dictaphone, which meant that I was fully able to concentrate on the content of the interview and not risk the distraction of note taking. This was invaluable in maintaining the conversational flow outlined in a semi-structured interview.

3.5.7. Sample size

Table 3.2. Illustrating the completed interviews.

Date	Participant	Position	Length (minutes)	Roles
3/8/2016	1A	Senior information governance officer	86	Initiator
5/8/2016	1B	Intelligence officer	62	Computer scientist
12/8/2016	1C	LA associate startup business owner	45	Computer scientist / communicator
16/8/2016	1D	Freelance data visualisation practitioner	51	Data scientist / communicator / journalist
24/8/2016	1E	Citywide intelligence manager	71	Project manager
30/8/2016	2A	Intelligence and analysis officer	61	Data scientist / communicator
30/8/2016	2B	Communications manager	58	Communicator
30/8/2016	2C	City intelligence manager	65	Project manager / communicator
27/9/2016	3A	Business intelligence strategy and policy manager	66	Project manager
27/9/2016	3B	Head of business intelligence	71	Communicator / data scientist
29/9/2016	3C	Business partner	44	Data scientist / communicator
4/11/2016	4A	Policy and performance manager	65	Project manager / communicator
4/11/2016	4B	City-wide intelligence manager	68	Computer scientist / communicator

4/11/2016	4C	Graphic designer	54	Designer
4/11/2016	4D	Marketing and communications officer	71	Communicator
4/11/2016	4E	Intelligence and analysis senior officer	29	Data scientist
26/8/2016	5A	Academic	40	Cognitive scientist
26/8/2016	5B	Academic	35	Data scientist
7/11/2016	5C	Data visualisation specialist	55	Data scientist
10/11/2016	5D	Data visualisation specialist	35	Designer / data scientist
13/11/2016	5E	Infographic / data visualisation specialist	41	Journalist / data scientist

3.5.8. Time frame

The time it took to arrange interviews varied greatly between people and within case studies. In most cases, participants found time within the same week. In one case study, there was an official research application route. This meant that the time taken to arrange interviews stretched into a period of months. Although this was out of the control of the participants, they appeared unaware of any of the protocol beforehand and remained in touch with me during this process.

3.5.9. Interview analysis

In order to mobilise the interviews from data into insight, I began the process of transcribing the interviews. I transcribed the interviews in as much detail as possible, covering not only the conversation but also any pauses and non-verbal cues. Once completed, I used NVivo qualitative software to code the interviews. I used a mix of inductive and deductive coding in order to explore the themes, which were drawn from the literature review – notably the five key frameworks. I also explored any emerging themes, which were drawn from the interviews themselves. The main drawback of transcribing and coding interviews in this way is that it is often a very laborious and time-consuming process. However, due to the number of participants and organisations, transcribing the interviews in this way provided a significant opportunity to revisit each of them. Finally, coding using the NVivo software helped to provide simplicity, structure and organisation, which centered on the five key frameworks, as previously identified.

3.6 Reflections

In reviewing the interview process, there are a number of points, both good and unfortunate, which contributed to the path the data collection followed. The major hindrance I encountered was in contacting a main participant of a case study who lost his job in the intervening time between the

completion of the case study framework and arranging the initial interview. As a result, he no longer wanted to participate in the research. Although he helped me to communicate with his replacement, he did not want to contribute and as such I lost a key access point and insight, which showed an initial insight into the economic context and turnover of staff at local authority organisations.

In another example, the intended department was in the process of restructuring. As such, the intended interviewees were not able to offer any great detail of insight into their own ways of working. I considered conducting a retrospective case study, but due to the nature of data visualisation as a subject in transition and development, it was considered best to remain focussed on the active and current practices which were occurring.

However, these setbacks were complimented by the amount of good fortune received during this process. On numerous occasions, I benefited from interviewees having appointment times available due to cancellations at short notice. Due to my own flexibility, I was able to take full advantage of this. In another instance, after making contact with a local authority, one interviewee began to draw up a list of potential contacts from within that organisation, whom he approached on my behalf.

Overall, each of the chosen mixed methods approaches as adopted in this study complemented each other. The initial broad scoping survey fulfilled its role in providing context and general information for the operational practices, as well as gaining numerous participant contacts and unlocking access to some organisations which would otherwise have remained closed. The transition from survey to case study creation allowed for a much more in-depth and precise look at the actors, intermediaries, philosophies and organisational working structures which influence the unfolding practice. Although some participants were slightly more reserved, I found there was a positive sense of achievement and progress from the participants engaging with data visualisation, who were therefore happy to share their stories. Equally, those who were frustrated seemed to enjoy having the time to vent, particularly about the hierarchical or political processes involved, which was just as beneficial to the data collection.

4: Local Authority Case Studies

4.1 Introduction

In the previous chapter, I outlined the chosen methodological approach, which is to be enacted to form the remaining empirical chapters of this thesis. The following chapter presents findings from the first stage of data collection, illustrating a descriptive account of the survey results and the case study selection criteria, before exploring each chosen case study in depth to provide the economic context and service obligations and their engagement with data visualisation. The final section of this chapter triangulates the working practices of each case study organisation to illustrate the similarities and anomalies in the production of data visualisation and the operational working conditions within local authorities.

Section 4.2 explores the results from the initial broad scoping survey and presents findings from 81 local authority respondents. The survey provides a descriptive account of the types of authorities and subsequent services they deliver, the scale of difference between population size and the economic challenges facing authorities. It then highlights the three key working pathways in the production of data visualisation and the role of specialists, training and the scope of maturity of engagement. This section ends by readdressing the case study selection criteria and the chosen case studies.

Section 4.3 focusses on the first case study organisation, Authority 1. It illustrates the size of the local authority through its high dependent population of approximately 700,000, as well as the types of services it delivers as a metropolitan district council. It then draws attention to the structure of the organisation and its economic context and the effects of austerity, noting the £180 million reduction in core funding from 2010–2017. It then explores the process of production in relation to data visualisation and mobilises Kirk's (2017) eight roles to help illustrate the comparative working strategies. It concludes by addressing the extended network of data actors, in the form of associates, who are involved in the production of data visualisation at this organisation. Further information on this organisation can be found in appendix A.

Section 4.4 addresses the second chosen case study organisation, Authority 2. It illustrates the services it is responsible for as a non-metropolitan council. It also highlights its large dependent population of almost 500,000 (number approximated due to anonymity). It again provides the economic context for the organisation and depicts Authority 2 as having already made £100m in savings from its budget since 2010. It is expected that this figure will rise by a further £30m by the end of the 2018/2019 forecast. It then draws attention to the strategy of data visualisation at the case study, noting its business-orientated management structure and approach. It again mobilises Kirk's (2017) roles of data visualisation production in order to identify and compare the strategies employed within this organisation. Further information on this organisation can be found in appendix A.

Section 4.5 discusses the third chosen case study organisation, Authority 3. It highlights its size through its dependent population of approximately 40,000, which is just above the minimum requirement for a unitary authority. The small dependent population is reflected in the small workforce and reduced structure comparative to the other cases. Despite this, it is still required to deliver all services in keeping with its status as a unitary authority. This section also provides the economic context of the organisation and its working practices, highlighting the effects of austerity spending measures, which have produced required savings of £9m since 2012/2013. The final subsection of Authority 3 draws attention to its working practices in relation to data visualisation, again highlighting the work of Kirk (2017) in addressing the roles of production. Further information on this organisation can be found in appendix A.

Section 4.5 focusses on the final case study organisation, Authority 4. It represents a larger urban case study with a population of approximately 260,000. It is a unitary authority and as such is responsible for a wide range of services for its citizens. It takes a comparative glance at the economic context of the organisation and the effects of austerity, noting that in 2012 the authority faced a shortfall of £61m, with a further £45m required savings by 2020. This has led to large staff reductions, which have ultimately affected operational strategies. These are discussed in relation to data visualisation within section 4.5, as well as reflecting on the operational roles of data visualisation production as outlined by Kirk (2017). Further information on this organisation can be found in appendix A.

Section 4.6 presents a discussion of the process of production across each of the four case study organisations. By drawing on a collective account of the challenges facing the organisations, it illustrates that, despite differences in scope, location, size and service obligations, the production of data visualisation is faced with similar challenges. It also draws attention to the comparative solutions which are employed by each organisation.

4.2 Survey results

The following subsections provide a descriptive account of the findings from the first stage of research collection. A broad survey questionnaire was employed to give an insight into the different types of local authorities and their various mechanisms for engaging with data visualisation. The outlined research aims of the project meant that intensive qualitative methods were required for the second stage of data collection. However, before any in-depth case study investigation could take place, there remained challenges in understanding the scope, complexity and differences between local authorities in England. There were also further complications in interpreting each local authority's engagement, cultures and attitudes with regards to data visualisation. There were few public-facing policy documents around data visualisation strategy on a national scale to consider. Therefore, a survey questionnaire into local authorities and their engagements with data visualisation was completed in order to gain a broad understanding of the types of engagements, hardware, software, required skills and processes of production, which were to inform the selection criteria for case study analysis (Sections 4.3, 4.4, 4.5 and 4.6). In total, surveys were sent to all 326 local authorities in England, with a total response rate of 81.

Section 4.2.1 explores the types of local authority in England, paying attention to structural differences, geographical differences and the services they deliver. Following this, section 4.2.2 illustrates the types of production processes. Specifically, it draws attention to the differences in software and maturities of engagement, before focussing on the networks of production, which include the availability of training, links to partner organisations, outsourcing and the sources of data. Section 4.2.3 then mobilises the survey results to identify the key variables in local authority data visualisation and to finally readdress the criteria used to select the case studies.

4.2.1 Local authority differences

There are 326 local authorities in England, varying in a number of key factors which influence the services they deliver and the local demands and priorities of residents. They can be split regionally across England and have considerable scope in size. They range from the smallest, of approximately 34,000, to the largest, of approximately 1.1 million, although the most common ranges sit in between

150,000 and 300,000. There are also varying economic contexts to consider when addressing issues on a national scale. The Index of Multiple Deprivation ranks each of the local authority areas on indicators of quality of life, which include income, employment, education, health, crime, barriers to services and the living environment. These ranking positions also give an indication of the local challenges and therefore their influence on the types of services and priorities of each local authority. These challenges are all contextualised by austerity spending measures in the UK, which have seen council budgets significantly reduced since 2010. The impact of austerity and the ability of councils to maintain standards of service delivery are often tied to the existing economic context within that area. These factors are mobilised in the forthcoming sections to help illustrate the varying contexts of each of the case study organisations.

Furthermore, local authorities in England are divided into four key types, each of which has its own service responsibilities:

- *Unitary authorities*, which are responsible for housing, waste management, waste collection, council tax collection, education, libraries, social services, transport, planning, consumer protection, licensing, cemeteries, police and fire services.
- *Metropolitan district councils*, which are responsible for housing, waste collection, council tax collection, education, libraries, social services, transport, planning, consumer protection, licensing, police and fire services, cemeteries.
- *Non-metropolitan councils*, which are responsible for waste management, education libraries, transport, social services, strategic planning, police and fire services, housing, waste collection, council tax collection, local planning, licensing, cemeteries.
- *London boroughs*, which are responsible for transport, strategic planning, regional development, police and fire services, housing, waste collection, council tax collection, education, libraries, social services, local planning, consumer protection, licensing, cemeteries.

4.2.2 Differences in production

There were various data sources identified through the survey results. All respondents noted that their own local authority organisations provided some data to be visualised, whilst 52 respondents additionally cited using data from another local authority. There were also a large number of organisations utilising open-source data in their visualisations, the most common one being the Office for National Statistics (65). Furthermore, some organisations paid for subscriptions to data sets and data profiling tools. In total, five respondents operated with Experian (a credit referencing agency), and three respondents utilised Bluesky (a geographic information company) to gain access to a range of spatial data sets.

The software used by each local authority can be divided into four main categories. First, statistics software, such as Microsoft Excel, was noted by 63 respondents. Second, the more complicated analysis systems, such as R or SPSS, were used by far fewer respondents (five in total). Third, there were a number of respondents who worked specifically on graphical or design-based software (25 respondents), such as Adobe Creative Cloud. Finally, all the participants noted using some form of GIS-specific software, with ArcGIS and Cadcorp being the most common (33 responses each). The software used is an important indicator of an authority's engagement with data visualisation and the culture that exists within that organisation. Only a small number used specific data visualisation software such as Tableau, which suggests that fewer designers are connected with the current field of data visualisation as outlined in section 2.3, or that the organisations are unwilling to invest in licenses for data visualisation-specific software. It also gives an indication of the complexity of the visualisations being produced. The chosen statistics software is also an indicator of the complexity of the analysis being conducted, as a larger number of respondents favoured Excel, which highlights that they are working with smaller data sets and less complex visualisations. The software choice also reflects the paradigm of the creator – as discussed within the literature review (Chapter 2), data visualisation is an interdisciplinary field which encompasses computer science, statistics and art. Therefore, the software choice could be an indication of the school of thought in which the creator sits: the computer science, academic perspective using complex statistical software, or the artistic or data visualisation practitioner using more design-based platforms.

Data visualisation training within the organisation was also addressed within the survey. In total, 12 respondents worked in organisations which delivered internal training. This was noted as being software-specific training and the use of online modules relating to data visualisation creation. There were 24 respondents who had received training externally. This included training from other government organisations, such as Public Health England, and online courses. No training had been provided internally or externally by the organisation in 45 respondent organisations. However, 17 of those respondents noted that they had previous academic experience, such as relatable university degrees, or had sought out their own software-specific training courses for packages such as Tableau. The type of training provided is in keeping with the current practical focus of the field of data visualisation. The academic backgrounds and previous experiences of participants are important as they are likely to shape their focus and creation of data visualisations.

There were also different pathways of production, which can be split into four processes. Thirty-four organisations worked with a specialist design team or individual who was responsible for the creation of data visualisations. In 16 organisations, staff were responsible for applying and creating their own

visualisations, whilst 30 responses were categorised as having no formal approach to data visualisation. Participants revealed that this was mostly due to time constraints and staff numbers.

We used to have a specialist mapper but he has left. (Response 18)

It depends who's available, some staff are better than others but it all depends on how much time there is. (Response 43)

A total of nine respondents suggested that data visualisations were primarily created outside of the organisation; this came in the form of outsourcing design work to neighbouring local authorities or local university staff and students, and outsourcing data management to private businesses. Similarly, 20 organisations occasionally worked with partner organisations in their operational practice of data visualisation. The most common partners were third-sector organisations and other local authorities. The roles of the partners differed and can be categorised into three processes: collection of data, management of data and design.

The target audiences slightly favoured internal staff from within the organisation (78 responses), compared to 72 responses for public-facing documents. Less common results show that 21 organisations used data visualisation as a tool for communicating with councillors and elected members. In order to interpret the complexity of engagement, respondents were given a list taken from Evergreen (2017) and asked to select which chart types their organisation utilises. The results show that almost all organisations engaged with basic data visualisations: bar charts (80), pie charts (80) and basic maps (78). As the complexity of the visualisation increased, the engagement reduced, with the least used being population pyramids (21), scatter plots (21) and spider charts (7). The outputs also show different levels of complexity, with data visualisations being used in public and internal reports (79) and internal presentations (75), whilst more complex uses such as dashboards were used in 40, and apps in 20.

4.2.3 Key factors of local authority data visualisation

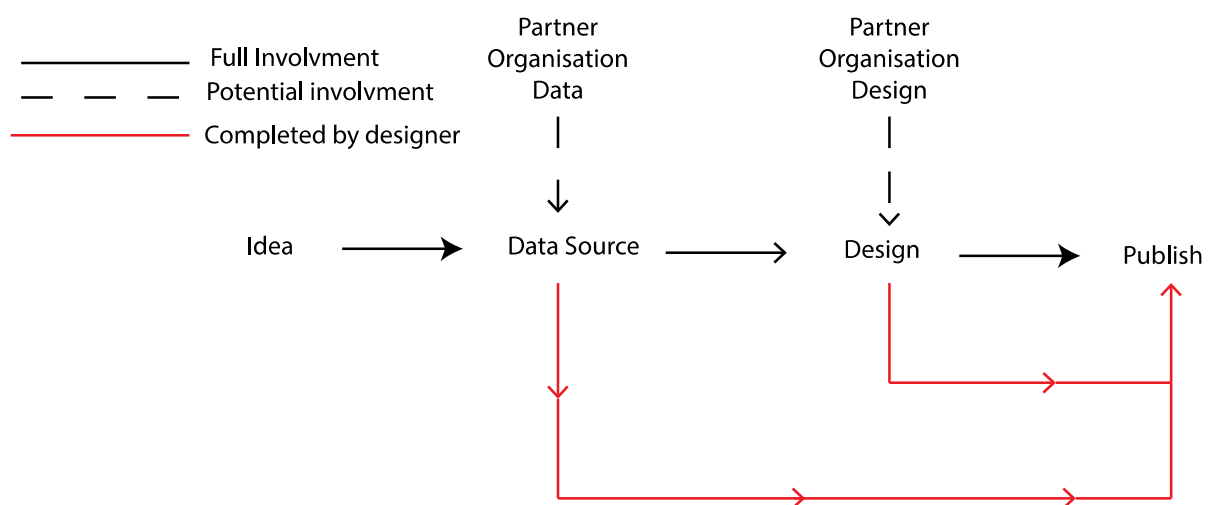
The previous subsections have drawn attention to the differences between local authorities and the multiple ways in which they engage with data visualisations. This introductory and descriptive look into these processes has enabled us to create an understanding of the types of local authorities in terms of geography, services and economic contexts, pathways of production of data visualisation and their maturity of engagement. This has allowed us to create a framework of selection criteria from which to select the forthcoming case study organisations. Because of the complexity, scale and variability identified in both local authorities and their use of visualisations, it is not possible to pick a case which represents a single set of characteristics. Therefore, to get a holistic impression, it is required to incorporate multiple cases which overlap in certain aspects.

4.2.4 Case study criteria

As mentioned in the previous chapter, the survey analysis has helped to identify key local authority types of data visualisation engagement and creation. I will again address the pathways of production and the five criteria which helped to inform the case study selection, which contributes to the remaining analysis chapters of this thesis.

In trying to understand how local authorities engage with data visualisation, it is important to gain an insight into the how the processes are shaped by the geography of each organisation. The size of an authority and its population are potentially important, as they have a direct influence upon service delivery, resources and number of staff. The location can also inform numerous influential factors such as demography, economic context and the priorities and goals of local authorities and their citizens. With this in mind, there is also a wide range of operational procedures within local authorities that influence the practice of data visualisation. These can differ between authorities and are a product of the specific staff, skills, leadership decisions, organisations and practices of each specific working environment. The figure below has been informed by data gathered from surveys. It illustrates the multiple pathways of data visualisation creation in local authorities. The black flow represents the completion of the entire process from data sourcing to publication. However, some actors will only be present at certain moments. The actors can be split between designers (data visualisation experts) and organisers (managers, team leaders and front-line staff).

Figure 4.1. Pathway of production of local authority data visualisation.



As a result, the following case study framework has been created in order to ensure that the most informative case studies have been chosen.

Criterion 1: All case studies should exist within Figure 4.1.

The intention of each case study is to give an in-depth understanding of a particular way of working adopted by local authorities, incorporating those who have specialist teams, and those who collaborate with organisations in design and the varying sources of data. While each case study highlights one particular process, collectively they illustrate production processes on a national scale.

Criterion 2: Together, all case studies should aim to give a representation of the contexts in which local authorities engage with data visualisation.

Local authorities are working in challenging environments and are required to maintain high standards of service delivery, transparency and public consultation. Each case study provides a different perspective, and collectively they highlight the varying operational uses of contexts in which data visualisations are practiced within local authorities

Criterion 3: Case studies are chosen due to their high output of data visualisations.

This criterion is self-explanatory, but it is necessary when understanding how data visualisations emerge in different contexts that each case study will be actively engaging with data visualisation.

Criterion 4: Individual case studies must highlight differing maturities of engagement.

This refers to the skill and complexity of the typography of data visualisations. Although all case studies must have a high output, as mentioned above, the case studies must be representative of all abilities, resources, aims and outcomes regarding data visualisation.

Criterion 5: Case studies should show a willingness to engage, and be able to provide access to a wide range of actors across the production pathway.

This criterion is a necessity of researching and of the time constraints associated with completing a PhD. All cases must be able to provide access to a range of actors in order to interpret a data visualisations post-representationally.

4.2.4. Selected cases

These criteria were applied after the first phase of data collection and four case studies emerged as obvious choices. The name of each local authority has been replaced by a pseudonym:

- Authority 1
- Authority 2

- Authority 3
- Authority 4

Each of the outlined cases is discussed in the following sections of this chapter, before presenting an account of the processes of production and working practices, which are common across each of the cases. This chapter critically inspects the benefits and drawbacks of each and considers the anomalies and outliers in particular cases. It considers the roles of practitioners in relation to Kirk (2016), the drivers of production, assumptions of data and constraints.

4.2.5 Summary

The previous section discussed the structural, cultural and economic differences between local authorities and has brought attention to the types of production pathways of data visualisation creation in local authorities. It has mobilised the results of a broad survey to shed light on these processes, allowing us to make an informed decision on case study selection. The criteria for selection aim to cover the key differences between local authorities and engagement with visualisations, so the case study organisations are able to provide an in-depth account of the specifics of the working practices. The remaining sections of this chapter focus on each of the four chosen case study organisations.

4.3 Authority 1

4.3.1 Introduction

This section presents the findings of the first local authority case study. It provides an insight into the wider context and scale of the particular operational challenges facing this organisation. These are addressed through investigation of themes of geography, economy and demography. The aim is not only to paint a portrait of the challenges facing the authority, but also to understand the role of the authority in the lives of its citizen customers and how embedded the authority is within the local environment. In addition, in so doing, it will provide the context in/from which visualisations are produced.

The first section begins by outlining the key geographical features of the authority. It highlights the area in which it exists, its population catchment area and its urban environment. The second section looks into the make-up of the population in the local authority's catchment area. This remains significant as the age, workforce and employment statistics correlate with the ever-increasing and forecasted rise in demand on social services. The structure of the organisation is then presented on a departmental basis. This helps to highlight the types of work being conducted by the authority. Following this, the services which are delivered by the authority are considered, representative of a metropolitan district council. The authority's services are then contextualised through the challenging political context of austerity

spending cuts, examining the effect of reduced funding from central government and increased demand on spending capacity. The significant challenges to the capacity of this organisation to deliver the same standard of service delivery are considered. This section illustrates the changing pressures of austerity on service delivery from 2010 to the latest budget in 2017. The concluding section examines how the factors mentioned above have led to a change in the way in which services are delivered and the role of data visualisation as a city-wide tool for efficiency and innovation.

4.3.2 Geography

This council is located in the historical county of Yorkshire. This is the largest county in England, spanning over 2.5 million acres. The county itself can be considered as having three key areas: the north, east and west. Whilst the north and east are predominantly rural locations, the west is urbanised, and it is on this area that this case study narrows its focus. Authority 1 is a metropolitan district council, one of 36 in England. It is the largest urban case study in terms of geographical size and the second largest in total population. The dependent population of the authority is 600,000–800,000 (number approximated for anonymity), which is spread over 30 wards. In the past, the scale, size and prominence of the authority has remained integral to the local economy: it employed over 30,000 staff in 2010, although changes to spending capacity in the last decade have had a significant lasting impact, which will be discussed in the following section. The number of councillors again reflects the size of the authority. There are currently 100 councillors (actual number approximated for anonymity), two thirds of whom represent the Labour Party, with the remaining third split between Conservative, Liberal Democrat and independent candidates.

4.3.3 History and structural change

Authority 1 was founded in 1974 because of the Local Government Act 1972. This meant that the traditional county borough was combined with a further seven boroughs in order to form a new second-tier metropolitan district council. It has remained in its current form since the time it was established, unlike the following case studies, which have been influenced by varying structural and organisational changes. It has been influenced and impacted by several government statutes, which have played a key role in shaping the statutory services of contemporary authorities.

In its original guise, the functionality of the authority was limited, as many key services were carried out by West Yorkshire County Council. However, the 1985 Local Government Act led to the abolition of the six county councils of the metropolitan councils. As such, Authority 1 became responsible for all the key services of the former county council, except fire services, public transport and policing. Further structural changes occurred in 2014, when Authority 1 became a constituent of the West Yorkshire

Combined Authority (WYCA). The WYCA is a strategic authority which operates through three committees focussing on investment, transport and governance and audit.

In its current operational context, this case study authority has a responsibility to deliver a wide range of public services, a summary of which can be found in the appendix.

4.3.4 Demography

The demography of Authority 1 reflects the duties of care and priorities of this authority. Its ability to deliver these services and meet the needs of its residents has become strained as high priorities and increased dependency from vulnerable customers have coincided with continuing reductions in spending capacity.

One major issue facing the authority is that there are over 100,000 residents above pensionable age (Nomis, 2017). This has created a great demand for care and accommodation. As such, Authority 1 prioritises adult and children's social care, retaining as much spending power as possible, as expressed in the 2017 budget (Authority 1, 2018), which is discussed in more detail in the following subsection.

Other notable areas of population dependency continue to place a strain on financial resources. Almost 60,000 residents describe their mobility issues as affecting their day-to-day activities 'a lot', whilst 66,500 residents describe them as affecting their day-to-day lives 'a little' (Nomis, 2017). There are also a large number of residents who provide unpaid care, with 45,600 providing up to 19 hours per week, 10,000 providing 20–49 hours and 16,500 residents providing more than 50 hours. These statistics give an insight into not only the dependency of the residents in terms of services and care, but also the capacity for full-time employment. Unemployment is an issue for the authority, with 19,200 registered unemployed. There are also large numbers of the population registered unable to work, with 3,500 registered disabled and a further 32,100 claiming Employee Support Allowance (ESA) or incapacity benefits. There is also a higher proportion of 20–24-year-olds compared to the national average due to the significant student population. There are over 65,000 students, and again this presents challenges to the local authority in terms of delivering quality of life, local services and economic opportunities to increase retention post-graduation.

4.3.5 Structure

In terms of authority structure, working departments unfurl beneath the corporate leadership team, which is the council's senior management team. Beneath that there are six key directorates, and within each of these are the more targeted and focussed departments who are responsible for the front-line

operations and pastoral care of the city and its inhabitants. The departments are listed below, and a full breakdown of the roles of each department can be found in the appendix:

- City Development
- Communities and Environment
- Resources and Housing
- Children and Families
- Adults and Health
- Public Health

4.3.6 Austerity

The following quote is from a council leader discussing the most recent budget:

the budget setting challenge this year has been the most difficult I have ever been involved with, facing choices none of us would ever want to make, but there is simply no other way, the money is just not there anymore. (Iqbal, 2018)

The environment in which local authorities operate continues to be one which presents significant financial challenges, Authority 1 is no exception. The 2010/2011 and 2015/2016 budgets showed that Yorkshire authorities' core funding from central government had reduced by approximately £180m. The budget for 2016/2017 saw further reductions of £31m.

The 2017/18 budget will again require significant savings and it is expected that greater savings will be required beyond this. This is compounded by a continued rise in demand for services and the current more general economic climate, which has forced some difficult and challenging decisions on behalf of the authority. In 2015/2016, following consultation with the public, the authority pushed for Authority 1 to promote a 'city that cares'. As such, adult and children's social care has remained largely protected. However, there was an overspend of £5.8m in the cost of placements for children looked after by the council, and an overspend of £2m in the cost of home-to-school transport, due to a larger number of children being educated outside of the city.

To cope with the rising challenges in the face of austerity spending measures, the council has outlined two key drivers to continuing its service delivery: seeking more 'efficient' modes of work, and promoting new pathways of service delivery through 'innovation'. This council has taken two distinctive approaches: sourcing efficiencies and mobilising innovation as a tool for stimulating good economic growth, and creatively managing demand for services. This whole-city approach drives

ambitious plans despite austerity. This approach, coupled with a significant programme of more traditional cost cutting, has enabled the council to make the £400m of savings. One key area of savings has been created by reducing the operational size of the authority. A reduction in full-time equivalent (FTE) employees has meant that immediate and pre-planned redundancies have become increasingly common. A £2m reserve to cover the cost of severance in the Early Leavers Initiative hopes to generate long-term savings by reducing staffing numbers. According to the 2016 budget, staff size has reduced by 2,500 FTE employees since 2010. These changes are to be escalated by a further 800 cuts by April 2018. It is hoped that this change in operational structure can help to create savings of £55m per year. Key savings include:

- Staff reductions of 2,500 without compulsory redundancy, saving £55m pa
- £2.4m savings from changes in terms and conditions of staff
- Over 50% reduction in agency staff since 2013
- Over £35m of procurement savings since 2010/2011
- An annual saving in the cost of waste disposal of approximately £7m
- The completion of the Recycling and Energy Recovery plant in 2015

In the face of budget cuts required by austerity budgets, and against a backdrop of mounting social pressure, the council is seeking alternative ways of working, in order to keep evolving and innovating and to establish new efficiencies. This includes working with local partners and moving away from being solely a provider of services to adopting a more enabling role within the community. To encourage resilience, this also means that staff and the local citizens are encouraged to do more themselves, which allows them to prioritise and shift focus towards the most in need. These processes are all intertwined with and enablers of the operational use of data visualisation – a point summarised by Councillor A from Authority 1:

We need to look at new ways of delivering services or helping people (the public) to help themselves, be that through working differently with partners or making the most of new innovations and technology. (Participant 1A, Authority 1)

This illustrates the parallel positions of both operational staff and local citizens, who are both equally being encouraged to contribute in new ways, taking ownership of new tasks and doing more in their everyday performance. Of the £496.4m net revenue, almost 65% is prioritised to support critical adult social care and children's services, which reflects council priorities and feedback gained through public consultation and engagement. Over 50% of the budget supports the council's outcomes of 'Enjoy happy, healthy, active lives' and 'Live with dignity and stay independent for as long as possible'. Over 18% of

the budget supports services that help people to 'Be safe and feel safe'. A full breakdown of spending by services can be found in the appendix.

4.3.7 Data visualisation in Authority 1

Authority 1 influences and impacts upon the lives of the local population in a variety of ways. The authority has met the statutory obligations of openness and transparency. This is evidenced by the data hub, which has published data sets beyond the statutory requirements.

I want to release as much as we can. That is why we keep publishing data. There's no point in doing the minimum because that might not be the stuff people are interested in. (Participant 1A, Authority 1).

Recognising that in order to fully communicate their message with the public they need to first translate large data sets into a language more easily digested by the public, data visualisation has become the vessel for this public communication. However, the operational role of data visualisation within this is still in its infancy.

The roll-out and expansion of visualisation techniques to mobilise the data in day-to-day operations has become more prominent but is still considered to be the 'start of the journey' (Participant 1C, Authority 1). Currently, the principal areas in which data visualisations are being mobilised are those with direct customer- (public-) facing impacts. In the previous section, the structure of the organisation was broken down on a departmental level. Here I narrow the focus to three departments: Children and Families, Adults and Health, Resources and Housing. These departments are currently the focus of the authority's operational engagement with data visualisation. It is in these departments where the authority seeks to pursue more efficient and innovative ways of delivering its services. It is perceived that solutions can be found through examining open data streams by presenting the possibility of a more targeted and focussed approach to customer interventions. It is these areas which have received the largest staff reductions. They can be considered as the pilot departments and therefore present a great opportunity from which to explore the unfolding of data visualisation.

Within the three departments outlined above, there is a belief that this is the beginning of a journey of transformation of service delivery within the city. The implementation of data visualization operationally is therefore still in a period of pilot projects and building partnerships and networks to optimise their understanding and use of data in the future. Therefore, current projects remain operationally inconsistent, being mobilised in one-off momentary projects and pilot investigations.

When discussing the creation and practice of data visualisation within the authority, the staff referred to the work conducted within the three departments highlighted above. This approach seeks to mobilise data (both secure and open-source) in order to explore new avenues to make service delivery more efficient. Similar to post-representational cartography (Kitchin and Dodge, 2007), these visualisations are enacted to solve problems and answer questions. Offering analysis provides an insight into large and complex data sets which were previously unmanageable and to communicate those findings to a wider audience.

Data actors

In the production of data visualisation within local authorities, it is important to broaden the understanding of data visualisation production from a purely design-based and aesthetic process to a more holistic one which is inclusive of the collaborative working processes which exist within large organisations. Within Authority 1, there is a specific data team who operate as project managers, initiating the focus of a project, sourcing the data and liaising between departmental experts and skilled data practitioners.

This process is collaborative with front-line staff from other departments. The authority remains keen to maintain the human elements of service delivery. The knowledge, skills and experiences of front-line staff remain an integral part of this process. Data and its visual forms are considered as ways to assist the front-line operational staff. This collaborative process seeks to engage discussion around the areas of service delivery which are most reliant upon a large workforce. The aim of this is to identify what problems staff are facing and whether data can be mobilised to identify solutions. Once this collaborative process has begun, the job of trying to solve the problems is left in the hands of data scientist. They operate on behalf of the teams identified above in order to find practical solutions through data and data visualisation.

The actors within this process can be split into three main categories.

Data leaders

These are the members of the data team in the authority. Their role is to mediate between the two groups of front-line workers and data scientists, whilst adhering to the logistical elements of the organisation's drive of 'open by default'. Although working within the data team, their background is not in data or data visualisation and they themselves are not considered designers.

My job is to try and glue the two sides together. I manage a team of data scientists and I speak with the other departments. I try and source the data, from one side, I give it to the other, then I send some results back and we discuss them. (Participant 1A)

Front line

These are the members of staff from within the authority who operate in the departments which are to become more streamlined through an integrated data strategy. Again, they have no specific data visualisation skills, but do have a wealth of knowledge on their specific department, the needs of staff and the desires of the public.

I work in Children and Families, I am basically a social worker, and I work on a case management basis. I have appointments; I speak to our customers and try to find the best solutions. (Participant, 1 E)

Data scientists

Employed on a 'when needed' basis, data scientists are contractors or freelancers working in the field of data science. Specifically, in this authority there are a number of regular data scientists who are employed as associates of the organisation, these staff are not local to the areas. One associate operates from within the Yorkshire region, whilst the other is based in London. This highlights that the role of the data scientist is not exclusive to the locale of the local authority. They use their training and expertise to analyse data or to communicate that data more effectively, in the hope of addressing service delivery issues.

I see my job as finding the key insights from the data, and visualising them is the main way I communicate what I've found back to the authority. (Participant 1C)

Data roles

Having identified the people involved in producing data visualisations in the previous section, it is important to understand the different roles they play. The production of data visualisation incorporates a variety of technical skills and knowledge that is representative of the overlapping disciplines in which the subject exists. While processes of data visualisation production have previously been restricted to technical design, ideas of data visualisation production as a journey through numerous disciplines is becoming more common. In expanding the perspective of data visualisation production towards a processual approach, it becomes possible to unpick the competing and contrasting perspectives and

knowledge. Here Kirk's (2017) work is instructive. He suggests that there are eight specific perspectives which incorporate a more holistic interpretation of how data visualisations come to exist:

- Initiator
- Data scientist
- Journalist
- Computer scientist
- Designer
- Cognitive scientist
- Communicator
- Project manager

Within Kirk's (2017) analysis, the role of data visualisation production lies firmly in the hands of the individual. However, in local authorities, these projects are often the result of a combined team effort in which roles can become much more fluid, with individuals covering multiple roles due to staff reductions (see section 4.1.1) and with varying degrees of temporality (discussed further in section 5.4). Influence can be felt both from the hierarchy above and laterally in an interdepartmental exchange. Let us use Kirk's breakdown of production in order to better understand which of these roles exist within Authority 1, to unpick the temporal nature and to highlight the reach of influence.

As Kirk states, there is one common role in production which he labels the 'project manager', who oversees the production process until completion. In this authority, an individual takes that role from the data lead team, who are assigned projects that they will follow through until completion. They also operate in a further two roles, acting as the 'project initiators' by sourcing the data and curating a team of specialists, and finally as the 'project communicators'. They reprise this role once the design elements have been completed. They are then responsible for understanding the needs and abilities of the users (Del Casino and Hanna, 2000). Often this includes adding further explanation, offering clarity and depth to the visualisation (see section 4.4).

Due to the political nature of the local authorities, this role is not completely autonomous. A cloud of governance and political interest weighs upon any decision to make data public, especially where performance is concerned. As such, the communicator operates within this hierarchical structure. (The political process and its implications for the unfolding practices are discussed further in section 4.5.)

In terms of creation, the designer role is completed by contractors and freelancers for the authority. The design-based production roles, which seek out the message of the data and construct it into a visual

representation, are completed by a single individual. Kirk identifies the data scientist, journalist, computer scientist, cognitive scientist and designer as key perspectives which need to be addressed. However, the freelance operatives all operate from within the computer science paradigm. This means that the data visualisations are shaped from a single discipline and offer a design which neglects the proposals of storytelling, graphic design, audience attention and cognitive science which have become increasingly popular in the contemporary expansion of the field of data visualisation (see section 2.2).

Figure 4.2. Leicestershire dashboard. An example of the type of visualisation produced by the designers at this organisation, 2018 (Source: www.leicestershire.gov.uk).

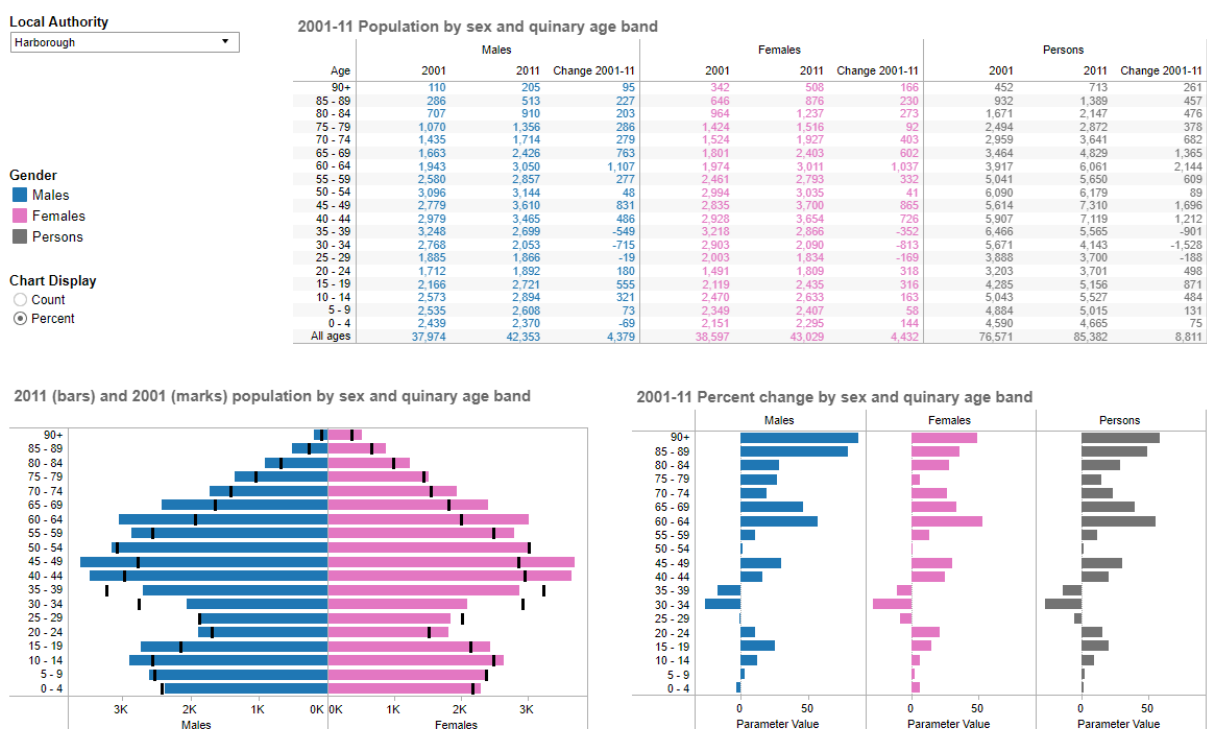
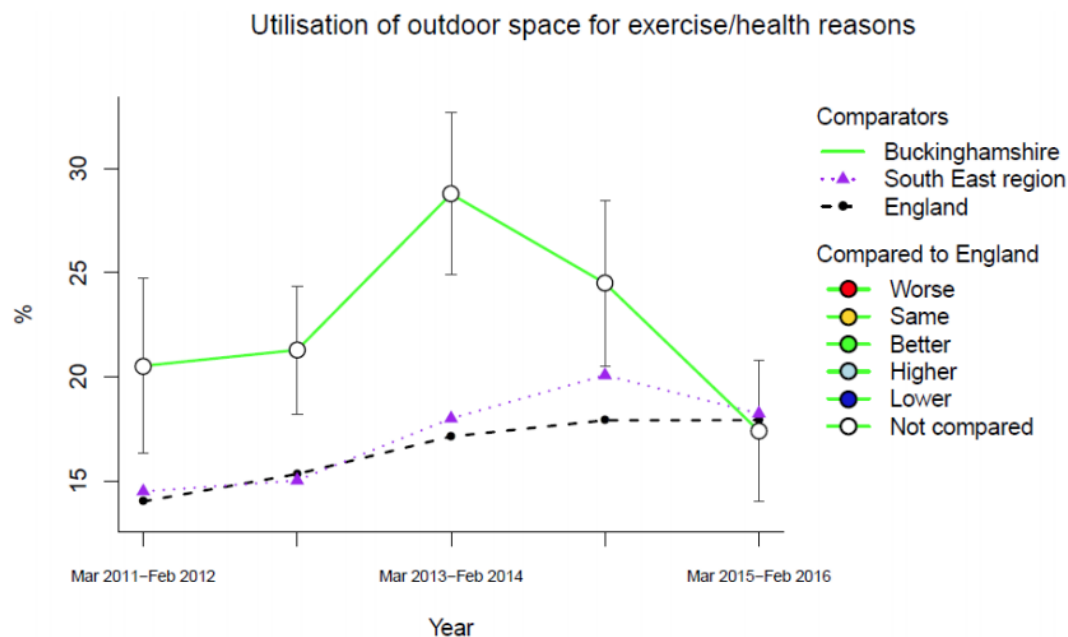


Figure 4.3. Examples of the types of visualisations being created within this department, 2018 (Source: <https://democracy.buckscc.gov.uk>).



Other stakeholders

Authority 1 operates with an ethos of ‘data for good’, which has become common in public organisations in recent years (see section 2.2). By promoting transparency and openness in their approach and resources, they hope to encourage potential new ways of working by beginning to promote a cross-organisational and city-wide pollination of ideas and strategies. This embraces the changing role of the authority as a key partner in a city-wide data strategy which seeks to mobilise data in a more integrated capacity amongst a wide ecology of actors, which includes the organisation, third-sector organisations and private businesses as a means to deliver a better quality of life for its citizens. It is also hoped that the role of the authority purely as a service and care provider by nature can re-establish its relationship with its citizens by adopting a more facilitative role, one that promotes resilience and brings together multiple partners, not necessarily providing the care for its citizens, but being able to bring together multiple organisations who, working together, can offer the same.

Authority 1 has outlined key stakeholders:

- Local digital community (digital companies, individuals and groups)
- Public sector
- Private sector
- Members of the public
- Third sector

- Council staff (as both publishers and consumers)

Local digital community

One of the key strengths of the authority is its ability to work in collaboration with an array of experts from within the digital sector. The geographical location of the case study has positioned it within one of the country's leading digital technology communities. The local digital community is an attractive mix of a well-established tech scene, a number of digitally focussed hubs and centres and a growing number of startups. There is also a diverse mix of meet-ups and socially focussed tech events hosted by community groups – such as Coding and Coffee, and Digital Drinks – which encourage those who work in the industry to meet and share ideas and knowledge. These factors have led to continued growth and the region is now said to be home to over 3,500 tech companies employing over 70,000 staff in multiskilled, digitally embedded roles (Tech Nation, 2016).

Data hub

One of the key influences upon this authority's culture of data visualisation is the online data hub. This web space offers the opportunity to publish data sets in keeping with Freedom of Information (FOI) requests and those of the INSPIRE directive. The platform provides a vault in which data sets are stored, presenting opportunities for the public and those within the digital community to explore, investigate and seek out understanding.

It also provides a place to highlight analysis in the form of visualisation, linking the completed visualisations thematically with data sets. Furthermore, it provides an opportunity to display the work completed both from within the authority and by those who are not employed in the organisation. This serves two main functions. The first is that it encourages further collaboration between the organisation and other stakeholders. Displaying the work of those outside the authority encourages inclusivity and values those outside the authority. Opportunities for further collaboration occur through sharing work. An example of this is the authority's city dashboard, which was created by a small organisation and, once published, the authority worked as partners in order to create a product which was exportable to other organisations. The other role of the hub is informative, to provide as much insight both internally and externally as possible. Authority staff are encouraged to use the hub to supplement their own work, while the public can explore data sets or view visualisations to understand the work being completed at the authority.

4.3.10 Summary

The previous section has sought to highlight the geographical context in which the case study exists. By providing an account of the social and economic challenges facing the dependent population, it

begins to paint a picture of the challenges facing the local authority. This contextualising case study has highlighted the ways in which public opinion and the desires of the dependent population continue to inform and influence the day-to-day operations of the local authority. The structure of the authority has been discussed to draw attention to the wide range of services for which the organisation is responsible. This helps to shape the understanding of the reach of data visualisation within the organisation.

The following section highlights the substantial effects which nationally imposed austerity spending measures have had upon the organisation's ability to maintain and deliver on its services, which meet the needs of its residents. It illustrates that tough decisions have been taken about the protection of adult and children's social care budgets, at the expense of other departments. This can also be considered as the main driving force behind a shift towards utilising data and data visualisations operationally. This is continually sought out through themes of innovation and efficiency.

This case study has drawn attention to the processes which influence the operationality of data visualisation. The two key approaches to data visualisation have been discussed, with attention given to the 'old and the new' of data visualisation – the new being the contemporary interdisciplinary approach to the field, which has become increasingly prominent in recent years (as discussed in Chapter 2). Following this, the actors, stakeholders and roles within the process of production were discussed, with attention being given to the significance of computer science. Finally, the strength of the local digital community has played a key role in the driving force for innovation. It has enabled the authority to seek advice, expertise and partnerships from fields which they would be otherwise unable to access.

4.4 Authority 2

4.4.1 Introduction

This chapter presents the findings of the second local authority case study. It aims to give an insight into the context and scale of this authority's services. These are presented through themes of geography, history, structure and economy. This is used to illustrate the challenges facing the authority and to help shape the context in which the operational role of data visualisation has grown.

The first section outlines the key geographical features of the authority. It highlights the location, its population catchment area and its rural environment. The second section investigates the make-up of the dependent population, focussing on age and employment, to highlight the demands placed on its services. The structure of the authority is then introduced on a departmental level to highlight the scope

and variability in the services it delivers. These services are then discussed in relation to the ever-increasing financial pressures which contextualise this study.

The second part of this case study examines how data visualisation is mobilised in order to seek out alternative forms of income generation. This section begins by examining the key actors and roles which are involved in the processual production of data visualisation.

4.4.2 Geography

Authority 2 is located in the south east of England. The authority is an upper-tier authority and a non-metropolitan county, one of 28 in England. As such, its services meet the demands of a typical non-metropolitan county council, which are discussed in more detail in section 2.5. The county council is split into four regions and represents the largest of all four cases. The size is further reflected by a large dependent population, approximately 400,000–500,000 (actual number protected for anonymity), which can be broken down into approximately 300 residents per square kilometre. They are represented by approximately 50 councillors (reduced from 60 following 2012 boundary changes), and the council is controlled by a majority of 41 in favour of the Conservative Party. They have been in power since the reorganisation of the authority in 1973.

The economy is modern service-based and in 2002 was in the top ten richest subregions in the European Union. It has the highest GDP outside of inner London. This is reflected in a high quality of life, life expectancy and educational results comparative to the rest of England. The county also has fertile lands which are used for agriculture, and it has a manufacturing industry which includes agricultural processing and pharmaceuticals.

4.4.3 History and structural change

Authority 2 was founded in 1889, following the Local Government Act of the previous year. From this, England was divided at a district level into rural and urban districts, municipal, county and metropolitan boroughs. This system was abolished by the Local Government Act of 1972 and as a result, non-metropolitan districts were created in 1974. England (outside Greater London) was divided into metropolitan and non-metropolitan counties. Initially there were 296 non-metropolitan districts in the two-tier structure. However, reforms in the 1990s and again in 2009 reduced that number to 201. Since its formation, the authority has represented five key regions within the county. This changed in 1997, when a single unitary authority was formed from its northernmost region. It has remained in this formation ever since.

As a non-metropolitan county council, the local services of Authority 2 are delivered in a two-tiered system, in which responsibilities are split between the county and a series of district councils. This formation allows tasks to be delegated to the most appropriate organisations. County councils are largely responsible for running the largest and most expensive services. A full list of services can be found in the appendix.

4.4.4 Demography

Authority 2's population rose by 6,320 in 2016, which is the second highest increase comparative to England's other county councils. As such, the number of residents per square kilometre has increased by 40. The composition of age groups shows some interesting trends: 20.3% of residents are aged 15 and below, which is higher than the county's average. There has also been a 13% increase in the over-65s in the previous five years.

In 2016, Authority 2's net 'in-migration' from parts of the UK stood at 1,829. The county has an overall net in-migration for all age groups except 15–19-year-olds, which saw out-migration of 7%. There are also 15,800 students in the county. This is lower than the national average and is illustrated by a particularly high out-migration among 19-year-olds, whose most common destinations are university towns. There is also a lower representation of people in their 20s and 30s and a higher than average representation of residents over the age of 95 when compared nationally.

There are a total of 290,000 residents in full-time employment, of which 57,000 are self-employed. Unemployment in Authority 2 is lower than the national average, with 7,700 unemployed (2.7% compared to 4.5% nationally). Other areas of economic inactivity include 14,100 people who are considered homemakers and 4,000 long-term sick, which again is lower than the national average (4.5%).

Employment type is weighted in favour of professional occupations. These include managers, directors and senior officials, who account for 155,600 employees. In the tier beneath, administrative, secretarial and skilled trade occupations account for 25,000 employees.

4.4.5 Deprivation

Authority 2 is ranked highly in the 2015 Index of Multiple Deprivation (actual position removed due to anonymity). The authority was the least deprived in the categories of health and education, skills and training, as well as ranking second least on income, and third least on employment and living environment. The authority does rank higher on barriers to access to housing and services. However, deprivation in this manner often reflects local challenges, such as low incomes in relation to local

housing costs. Distance to services such as GPs and schools also account for lower scores in those categories, which can often impact more sparsely populated or rural areas.

4.4.6 Structure

In terms of structure, all case studies are subtly different. Authority 2 is under the management of corporate leadership. The senior management team is responsible for overseeing a collection of departments. In total, there are four key departments that are responsible for public services. There is also a resources team, whose primary function is to assist with the day-to-day running of the authority. Finally, there is a separate team who are responsible for business intelligence and insight. Below is a list of each department in the organisation. However, a more in-depth breakdown of the role of each department can be found in the appendix.

- Communities, Health and Social Care
- Adults, Family and Wellbeing
- Children's Social Care and Learning
- Transport, Economy and Environment
- Resources
- Chief Executive's Services

4.4.7 Austerity

Authority 2 continues to face increased financial pressure. On both a national and local level, economic challenges have meant huge changes in how they are able to operate. These factors, coupled with the increasing needs of the local ageing population, the rising number of school places and growing social care costs, have continued to push Authority 2 towards a fundamental restructuring of service operations.

We are facing some tough choices. The gap between what we want to achieve and the level of support and services we can realistically offer is going to be a difficult one to manage without changes and reductions. (Council Leader B)

Responses to financial pressures

In response to these challenges, this case study highlights two key strategies. The first is a fundamental reorganisation of the role and duties of the authority. The first proposal is a switch to unitary status would mean that the current structure of five councils is replaced with a single council which would then be responsible for delivering all the services across the county. This would mean the formation of

a new senior management team and a new board of councillors. In September 2014, a study commissioned by the authority suggested that, over a five-year period, there were opportunities for savings of £13.4–26.9m from a two unitary model, and £44.6–58.3m from a single unitary model within the county area. However, the second approach to countering austerity is to seek out new streams of income, and to make more intelligent business decisions, which is to become the focus here. As one councillor states:

The ever-increasing budget cuts are forcing us to look into commercial opportunities [...] over the next decade you are going to see councils turning more into businesses. (Councillor C, 2017)

There is also a drive towards the digital. With £11.8m of investment arising as part of a local economic partnership scheme, the drive shift is integral towards the transformation of the council, allowing an opportunity to reduce costs, reduce contact time and maintain a standard of service delivery in future. It is the driving force behind a number of key priorities and is seen to enable the authority to deliver an efficient, effective, customer-focussed working environment.

Key savings

Authority 2 has already made £100m in savings from its budget since 2010. It is expected that figure will rise again by a further £30m by the end of the 2018/2019 forecast. The authority is also one of the lowest government-funded county councils in the country. It will be in the first three organisations to lose the entirety of its revenue support grant from central government (Walker, 2017). To give perspective, that is a reduction of over £85m since 2010.

In order to meet these financial demands, Authority 2 has continuously sought out savings. Unlike other authorities, who have sought out savings through reductions in net spend and staff size, this case has moved to create savings through increased income. This is illustrated by the increase in council tax by 4.99% in 2017, which it is estimated will increase by a further 1.99% by 2020 and will fund 79% of the 2017/2018 budget. Changes in business rate retentions have also meant £18.1m of generated revenue, which accounts for 15% of the 2017/2018 budget. Other streams of income outside the usual government revenue support grant play an important role in financing service delivery at this authority. A breakdown of alternative income streams can be found in the appendix.

Table 4.4. Authority 2's income sources, annual report, 2017.

	2017/2018 (£m)
Revenue support grant	8.1

Top up	25.9
Education services grant	5.0
New homes bonus	3.6
Transition grant	4.6
Other	4.4

Spending on services

The 2017/2018 budget highlights the priorities of the authority. It has sought to retain as much funding as possible for children and adults' social care. This reflects the local needs of a growing, ageing population and the continuous increase in demand for school places. The budget breakdown per service of 2017/2018 can be found in the appendix.

4.4.8 Data visualisation in Authority 2

As set out in the first part of this section, the size of this authority means that it is responsible for a large number of residents, spread over four districts. The effects of austerity have meant that the authority has been actively seeking new ways to maintain its standards of service delivery.

The authority has recognised that its sources of data can offer potential solutions towards a more targeted and informed set of operations. This has led to the implementation of a 'more robust data strategy' (Participant 2A, insight manager, Authority 2). This consists of unlocking the potential of local authority data sets, which it is noted have previously been stored in various places and are in languages that do not communicate with one another.

A good data visualisation strategy stems from a good data strategy [...] I can't emphasise this enough. (Participant 2A, insight manager)

It is anticipated that data sources can be mobilised in visual ways in order to communicate business intelligence to a variety of other stakeholders, such as business collaborators, councillors and the corporate leadership team. As the southern authority's funding from central government continues to reduce, it has begun to source other opportunities of income in order to counter impending losses. This has meant a change in attitude and approach towards commercial opportunities. One of the key areas in which the authority hopes to make strides involves data. This means recognising that the organisation is 'awash with data' (Participant 2B) and that 'data is the new currency' (Participant 2C). The authority insight and intelligence team operates by utilising internal data and external open data streams in order to understand and seek solutions to operational problems, eventually it is hoped they can expand the business model to attract wider corporate customer base. Data visualisation in this case operates within

a single department, the insight and intelligence team, who are located within the chief executive's services. The primary function is to visualise data to improve services and increase value for money for residents. The department is focussed on a corporate audience. To enable this, they recognise the need to continue to improve the way analysis is communicated, as highlighted in the quote below:

It's the final panache that's missing to communicate findings to the wider corporate audience.
(Participant 2A, business insight manager, Authority 2)

Within this department, there are ten operatives: four managers who operate as business partners (one for each of the four business units at the council) and a fifth manager of insight and intelligence who works on a council-wide basis as a liaison and communicator between other department managers. They also manage a team of five data analysts who work on a council-wide basis. Analysis conducted in this department covers all five of the service departments:

- Communities
- Health and Social Care
- Adults, Family and Wellbeing
- Children's Social Care and Learning, and Transport
- Economy and Environment

4.4.9 Processes of production

Observing data visualisations through a processual lens allows us to explore aspects of production as a continual series of decisions made by multiple actors. These processes influence how the visualisations are shaped.

The authority has designated that the insight and intelligence team is responsible for data analysis and visualisation production. Analysts aim to produce robust insights, which are turned into visualisations. These visualisations communicate findings to heads of departments, or are fed to the corporate leadership to inform policy decisions. There is also recognition that this phase of analysis may only be considered as the starting point. It is hoped that the analysis will drive further questions and prompt more research. This, again, prompts further discussion between management-level actors within the production ecology. Actors within the authority are quick to highlight the significance of the multiplicity of data visualisation production, alluding to the eight roles outlined by Kirk:

Really good data visualisations are a team effort between data scientists, statisticians and graphic designers. (Participant 2C)

A culture of collaboration exists within the insight and intelligence team. It allows a space for discussion and deliberation. This means that, within a single project, the visual can be absorbed and influenced by numerous actors.

The responsibility of visualisation production rests firmly within the insight and intelligence team. This is in keeping with the current data strategy and is a means of treating visualisations as corporate projects. In doing so, they reduce the risk of ad hoc creations being produced, and thus of potentially producing conflicting information. This also acts as a shield of quality control moving forward, allowing the authority to manage its outputs and begin to develop its portfolio to the wider corporate audience beyond the authority, which stretches beyond the local authority.

4.4.10 Actors

The actors involved in the data visualisation production process can be organised into four categories.

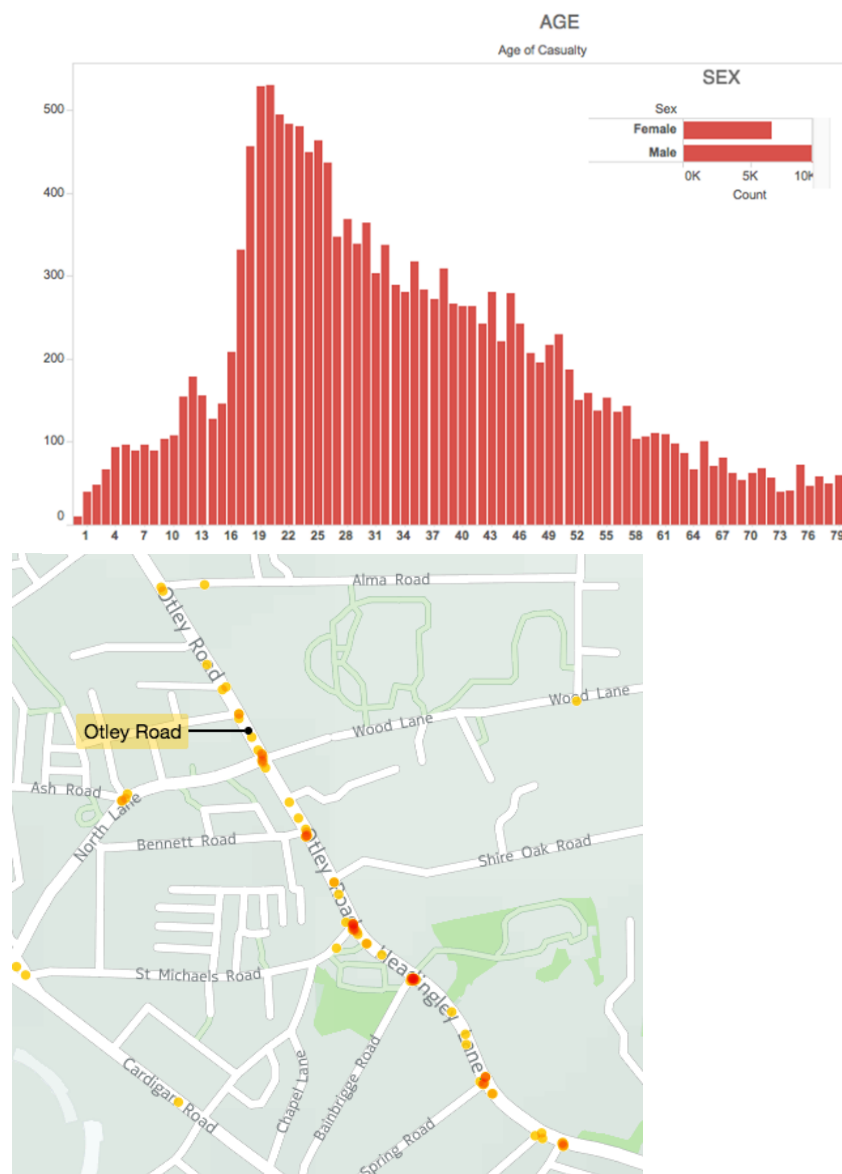
Data analysis

These are operatives within the insight and intelligence team. They come from a range of backgrounds across the data visualisation spectrum. The department houses a mix of those from the public sector and those who have previously been in business insight roles in the private sector. There is a wide range of skills in this department, including statistics, web design, GIS, data modelling and data analysis. There are also multiple software licenses for data exploration software, such as Tableau and Qlik. Participant 2B defines their role as:

To find ‘the story’ in the data and then communicate that in an engaging, insightful and simple way. Think data journalism. (Participant 2B)

Figure 4.4. Road traffic accidents in Leeds, 2017 (Source: <https://datamillnorth.org/>). An example of the types of data visualisation being completed by the data analysts at this organisation.

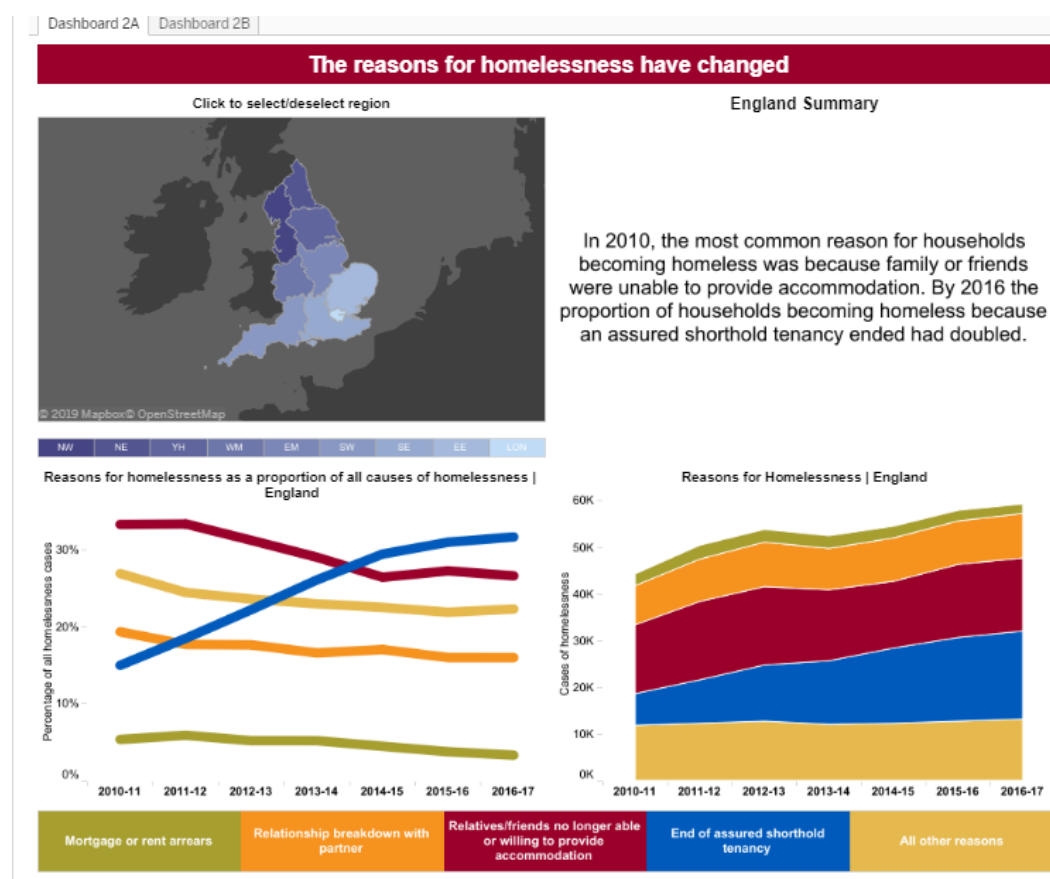
Figure 4.5. Further insight into road traffic accidents in Leeds, merging data with GIS, 2017 (Source: <https://datamillnorth.org/>).



Business partners

There are four business partners; each represents one of the business units at the authority, with backgrounds in business management and performance. They operate within the data analysis team, using analysis to monitor performance and target setting for the business unit.

Figure 4.6. Homelessness dashboard 1, National Audit Office (Source: <https://www.nao.org.uk/>). An example of the types of data visualisations used between business partners at this organisation, 2018.



Insight and intelligence manager

This actor previously held similar positions in the third and private sector. They have been employed in this position less than a year and have been employed specifically to overhaul and shape the data strategy at Authority 2. They also have a mandate to continue to drive data-based decision-making at the organisation. In terms of experience, they have a background in statistics, GIS and corporate insight.

I hammer home the operational and financial insights, and workshops (Participant 2B)

Department managers

These actors communicate with the insight and intelligence manager in order to grasp insights identified through data analysis. Visualisations are used to mediate this process. It is therefore important that the visualisations remain engaging and easy to communicate. It is then the department managers' role to expose that information to the front-line staff, and alternatively to prompt further points of investigation.

We communicate the findings with our staff on the front line. (Participant 2D)

4.4.11 Roles

When adopting a post-representational approach to data visualisation, it becomes possible to unpick the skills and decisions which are encountered as the visual is created and released. This also helps to emphasise the skills and backgrounds which shape and influence the aesthetic perspective of the visualisation. Data visualisation as a subject and as an artefact is by its nature interdisciplinary – a series of compromises and exchanges through numerous subjects. This is perhaps best depicted by Kirk (2017), who has identified eight key roles within the production of any data visualisation. Although these are discussed in the literature review (see section 2.3), they are repeated below.

- Initiator
- Data scientist
- Journalist
- Computer scientist
- Designer
- Cognitive scientist
- Communicator
- Project manager

Within Kirk's interpretation, these roles are conducted by a single individual. However, the size, scope and scale of work at this authority means that the data visualisations come to being through a team perspective. The following section aims to use Kirk's breakdown of production in order to better understand which of these roles exist within Authority 2. It aims to unpick the temporal nature of those roles and to highlight the reach of influence.

The role of the initiator is conducted by the insight and intelligence manager, who identifies which department's data is to be analysed. They then continue their involvement through the role of project manager, at which point they are responsible for logistical elements, such as time constraints and ensuring the aims of the project are met. The role of data analysis remains separate from the communicative, managerial aspects of production. The roles of journalist, data scientist and computer scientist are all conducted by the analysis team. Although individual projects are attached to individual analysts, there is a culture of collaboration, from which other analysts within the department question can influence and help shape the works of others. This adds a temporal quality to the roles within the department. In the final stages of production, the insight and intelligence manager reprises a third role, this time operating as a communicator, responsible for reporting insights to relevant managers. They can offer input towards the final redrafting of the visualisation. It is then their responsibility to mobilise and perform the findings verbally, depicting insights and analysis of the visualisation to colleagues. It

is at this moment that the engaging, communicative nature of the visualisation is entwined with that of the communicator, to ensure that knowledge has been transferred and absorbed.

Despite recognition of the importance of graphic design in the production of visualisations, there are no specific individuals responsible for graphic design at Authority 2. Instead, this role is offset by a reliance on data exploration software. Packages such as Tableau and Qlik offer pre-set design tools in which data analysis can be quickly transformed through a variety of bespoke visualisation templates. Front-line staff have very little input and influence upon the analysis or course of action which follows. In the previous case study, they were noted as being experts in their field, whose knowledge of the working processes should not be overshadowed by data. However, as mentioned previously, this authority has taken a much more corporate, data-driven approach to service delivery, which has left a lack of representation of front-line workers in decision-making. The role of the senior managers and councillors in these processes is purely as consumers, although as consumers they still influence the types of information they will receive. It is noted that they will only deal in ‘straight to the point, big picture visualisations’ (Participant 2A).

Other stakeholders

Aside from those directly involved in the organisation’s production of data visualisation mentioned above, there is a larger ecology of actors involved in the work of visualisations:

- Front-line staff
- Department managers
- Members of the public
- Business partners/ clients

4.4.12 Key strengths

One of the key influences upon this authority’s ability to cultivate and visualise data is the scope and comparative scale of its insight team. The number of staff in analysis and design is significantly higher than the other three cases. This means that a significantly higher workload can be undertaken, while the reach and influence of the department can be felt throughout the organisation. As such, this department has been more successful in creating a change in culture. Acceptance of a data-driven approach to decision-making has been quicker and more efficient than in the other cases. Authority 2 has also had the spending power to be able to strategically invest in skilled staff and appropriate software licenses, which again has allowed the department to continue to grow.

4.4.13 Summary

The previous section has discussed the second selected case study, Authority 2. It began by addressing its geographical and structural differences which make it unique to this research. It identified its required services as those of a non-metropolitan council, which delivers for a large dependent population. It also addresses the authority's economic position and issues regarding quality of life by discussing the council's low rank in the Index of Multiple Deprivation, which suggests a high standard of services and local infrastructure. In terms of austerity, this authority has sought to combat reductions through increased income. The second half of this section addressed the authority's approach to data visualisation and highlighted its business-focussed approach, which stems from the background and experience of the management.

4.5 Authority 3

4.5.1 Introduction

This section presents the findings of the third local authority case study. It aims to give an insight into its context, scale and operations. The challenges facing the authority are addressed through themes of geography, demography and the economic context in times of austerity. This case illustrates the unique operational processes of a small unitary authority. The second half of this case study examines the role of data visualisation as a solution to these operational challenges within the organisation.

The first subsection (4.4.2) begins to outline the key geographical features of this case study's location. It highlights the size of the county, placing emphasis on both its geographical boundaries and its small population. The second subsection (4.4.3) looks into the history of the organisation, examining the government reforms and statutes which have shaped the role of authority. The following subsection (4.4.4) looks into the make-up of the dependent population. It illustrates the typical livelihoods of the local residents, highlighting how indicators of deprivation compare nationally. The structure of the organisation is then presented on a departmental basis, giving insight into the types of services being delivered by the authority. This case illustrates the challenges of a small workforce in covering such a large scope of services, which are then contextualised through the challenging political landscape of austerity spending cuts. The consequences of this mean the authority now seeks new, more efficient modes of service delivery. This has presented opportunities for data visualisation, and Authority 3 looks to mobilise its data stores by adopting business intelligence approaches. The role data visualisation plays in these processes is discussed in the final section of this chapter (4.4.10).

4.5.2 Geography

Authority 3 is one of 55 unitary authorities in England and it is located in the north of England. As such, it is responsible for a wide variety of services for its local dependent population (this will be discussed in more depth in the following section). The borders of the authority represent its historical county. Due to its small size, its role and responsibilities as a council have changed since its initial inception in 1889.

Authority 3 is the smallest case study in terms of geographical area and it has a dependent population which is only slightly over the minimum 40,000 requirement for a unitary authority. The small dependent population places some unique demands upon the working conditions of the organisation. The authority is responsible for delivering a vast variety of types of services. However, it is faced with having fewer numbers of employees compared to similar unitary authorities. Authority 3 employs 164 part-time staff and a further 30 casual and temporary part-time staff. There are 248 full-time staff members. This results in staff operating more flexibly and undertaking multiple roles. The authority also shares some resources with a much larger neighbouring council (name removed for anonymity), which is discussed in more depth in section 4.4.10. There are three main towns within the county, which itself is divided into 16 wards. It is represented by 26 councillors and politically controlled by a Conservative majority. The remaining councillors are a split representation of independent candidates and Liberal Democrats. A large percentage of the population is of working age. This is split into three main sectors, with over 30% working in public administration and education, closely followed by 28% in the service industry and 17% in manufacturing industries.

4.5.3 History and structural change

This authority was founded in 1889, following the Local Government Act of the previous year, which divided England into rural and urban districts, municipal, county and metropolitan boroughs. However, this ended because of the 1972 Local Government Act. As a result, Authority 3 was dissolved as an organisation in its own right and was reconstituted as a member of a district council. This remained the case until the 1992 Local Government Commission for England. This review into local authority structure occurred between 1992 and 2002. Its purpose was to recommend the eventual creation of single unitary authorities. This resulted in the recreation of Authority 3 as a single unitary authority in 1997, meaning Authority 3 took back control of the majority of the services it delivers, excluding the fire, rescue and police services. As such, Authority 3 is responsible for a wide range of public services, a summary of which can be found in the appendix.

4.5.4 Demography

This section aims to give an insight into the types of challenges facing the authority as it aims to meet the needs of its residents. As mentioned previously, Authority 3 is the smallest case, both in

geographical size and number of residents. It has approximately 30,000–50,000 residents, of which 4% are under four years old and 21% are over pensionable age. The level of health issues is significantly lower than the other case studies, with 84.4% of residents considering themselves in good or very good health, and 3.5% considering themselves in bad or very bad health. This is also reflected in statistics around mobility, with 84% of residents considering their day-to-day activities to be not limited at all. Of the approximately 30,000 residents of working age, there are approximately 20,000 who are economically active, which can be broken down as 32% full-time, 15% part-time and 13% self-employed. In terms of the economy, manufacturing, construction, public administration and defense are the most prominent sectors. Nine thousand residents are considered economically inactive. This again can be broken down into 17% retired and 1.7% long-term sick. Nationally, this presents positive comparisons. Authority 3's 83.5% employment rate is higher than the national average of local authorities. Conversely, its 2.4% unemployment rate is lower than the national average of local authorities. Again, comparisons reflect positively on the authority when considering the number of Job Seekers Allowance (JSA) claimants.

4.5.5 Structure

In terms of the structure of this authority, working departments all unfurl beneath the council's senior management team. Beneath that, there are three key departments: People, Places and Resources. These are divided into a further five teams (two for Places, two for People and a single Resources team). Within each of these departments are the more specialised departments that are responsible for the front-line operations and pastoral care of the county and its inhabitants. The structure is listed below; a full breakdown of the roles of each department can be found in the appendix:

- Places A: Environment, Planning and Transport
- Places B: Development and Economy
- People A: Adults' Services
- People B: Adult Learning and Children's Services
- Resources

4.5.6 Austerity

Because we are already a low-cost council and spend less per household than most other authorities [...] this means using funds set aside to balance the budget in the short term. However, we need to be realistic and cannot sustain this approach over time. (Brown, 2017)

The rising financial pressures placed on the council by austerity spending measures have seen continued changes in the council's approach to service delivery. As highlighted in the quote above, the short- and medium-term effects of austerity have been counter-balanced by the use of financial reserves. Other key strategies for savings have been to engage community volunteer officers to assist with support (e.g.

a volunteer-led library reduces costs and alleviates the threat of closure). The long-term solution is for the authority to become more targeted in its decision-making. This is where visualisation comes to the fore as a solution and a means to continue service delivery in challenging times.

The authority has been subject to financial cuts imposed by austerity spending measures; it has seen continued reductions in funding dating back to 2010. Savings of £9m have been created since the budget set in 2012/2013. However, the organisation will need to find another £1.3m savings in 2018/2019 (Wainwright, 2016). Funding from the government's Revenue Support Grant has been reduced by £4.3m in 2015/2016, which will eventually lead to a complete removal of the grant by 2020 (Studdert, 2018). This means that during the same period, the authority's funding per household has reduced from £534 to £293. In the short and medium term, these savings have been offset by use of reserves and an additional transition grant from central government, creating an extra £1.8m for the budget. However, the use of reserves and the transitional grant is not sustainable. It is estimated that, by 2022, the council will be facing a £1.4m funding gap (Wainwright, 2016). The authority has had to reduce spending in key areas. The 2017/2018 budget proposes a drive towards volunteer-funded services in areas such as libraries, which will enable £100,000 of savings in staff costs. There are also proposals to increase council tax, which previously saw a rise of approximately 4% in 2016. Again, this will increase in 2018 by a further 1% to create savings of £1.5m. Finally, the authority hopes to create savings of up to £45,000 by stopping cash transactions at the organisation. The 2018 budget also highlights key savings created by services. By reducing teacher training and removing funding for support staff, children's services are able to save £100,000. Adult social care prices are to increase from £170 per week to a maximum of £300 per week, which will create savings of £125,000. Transport services are to create savings of £150,000 through further reductions in street cleaning, grass cutting and road repairs. Despite reductions to key services at the council, there has been extra funding allocation for children's services. This means an extra £200,000 for disability services, £90,000 for transport costs for special educational needs children and an increase in £350,000 for fostering and adoption services. A full list of spending, broken down by directorate, can be found in the appendix. Key savings include:

- £150,000 in cut road repairs and street services
- £125,000 increase in care home costs
- £45,000 in removal of cash transactions
- £100,000 in reductions to training and support staff in schools

The previous section has highlighted the effects which austerity spending measures have placed on the council's budget. The small size of the council means it is low cost. As a result, they have been able to offset the medium- and long-term effects of austerity through the use of grants and reserves. The past

few years have seen continued mounting financial pressures. The amount of required savings has become unattainable through service cuts alone. Therefore, this authority is at the start of a process to integrate alternative approaches to maintaining service delivery. As such, data and visualisation techniques are applied to policy decisions, target setting and service outcomes. The size of the authority's staff and its ability to spend present interesting challenges to acquiring the appropriate technology and skilled personnel. The organisation offers three key operational protocols for reducing costs long term. Encouraging community participation and reducing contact time through technology are already operationally prominent. The third approach is to enable a more targeted approach to decision-making, brought about through data and visualisation techniques, the processes and application of which will be the focus of the second half of this section.

4.5.7 Data visualisation in Authority 3

The following section shifts focus away from the geographic and economic forces which are acting upon the organisation. Instead, it begins to draw attention to the ways in which data visualisations are produced and mobilised on an operational level. It does this by considering data visualisations in a processual manner. Data visualisations in this authority are created within the business intelligence team, which operates within the People department. This is the second inception of a data-driven approach to operations at this authority. It has previously stored all data sets and visualisations in a data hub, which became underused and underfunded. Eventually leading to the information supplied to become outdated and somewhat unusable. This approach to visualisation seeks to highlight their use of data visualisation as it has been since 2016, using insights derived from data to assist in decision-making, target setting and to influence operations. The attitude and culture of data visualisation from elsewhere in the authority seems to be one of novelty. Although there is an appreciation that it is useful, it is nonetheless considered to be an added bonus. As Participant 3A states:

They think that's great but it's the cherry on top. But visualisation should be the whole point of every meeting, not just a bonus. (Participant 3A)

The level of integration of data visualisation is still evolving. At the time of building the case study, the authority was reliant on expertise from neighbouring authorities and was continuously seeking out other avenues of appropriating skilled labour.

4.5.8 Processes

This subsection highlights the particular workflow in which data visualisations come to exist within this local authority. As mentioned previously, data visualisation within this organisation exists exclusively within the People directorate, which accounts for three quarters of the whole organisation. This is a

small operational team dedicated to business intelligence; it is here that data is analysed and visualised before being released to and communicated throughout the other teams in the People department. With this in mind, data visualisations are used to communicate insights into service delivery, budgets and performance, in areas such as adults' social care and education, and children's social care, education, skills and learning. The authority is keen to use data insights in collaboration with front-line staff. The primary function of the visual is to communicate performance and target data efficiently and effectively during meetings, which are usually comprised of a mix of front-line authority operatives and department managers. The manager of the business insight team – who performs the visualisation verbally to depict, clarify and explain the information to other staff – leads the meetings.

Data visualisation is at the heart of business intelligence and that's how we get people to engage in the data. (Participant 3B)

The size of the department is relatively small, consisting of a manager of business insight, a quality and control officer and four data operatives. In this department, the data operatives are responsible for analysis. Their role is to shape and cleanse the specific data into a workable state. A data visualisation expert from a neighbouring larger authority completes the visual design and aesthetic processes of production. This is representative of many authorities, who have large amounts of valuable data but lack the resources to best understand or mobilise it. This would then be returned as a visualisation ready to be communicated. As use of data visualisation across the authority continues to grow, the organization has tried to decrease their reliance on the neighbouring partner authority, seeking ways to become self-sufficient in data visualisation design and practice. However, the economic pressures they face mean they are unable to recruit further staff or to upskill their current team, and they have therefore sought alternative partnerships. Currently they offer a work-based placement with a local university for Masters students. They offer an exchange of work-based experience for the skills and expertise of students in the field of computer science. Making the most of this partnership has enabled the authority to maintain expertise in visualisation at minimum cost. They are currently in the process of purchasing a desktop software license for Tableau data exploration software, which would allow the business intelligence team to have a dedicated member of staff and begin to produce their own visualisations on site.

Whereas previously targets and reports would be completed months after completed work and hoping they act on it, what we're hoping to do is having someone from our team sitting doing data visualisation and being active in the meeting to show what's happening on the fly. (Participant 3A)

4.5.9 Actors

In the process of creating data visualisations at Authority 3, the actors can be split into three main categories.

Business insight operatives

These are operatives within the business intelligence team who are responsible for data analysis for the entire People directorate. They come from a range of backgrounds and have experience in statistics, GIS and data management. They also all have experience of public-sector employment. Their responsibilities include FOI requests, data cleansing and creating workable spreadsheets of multiple data sources.

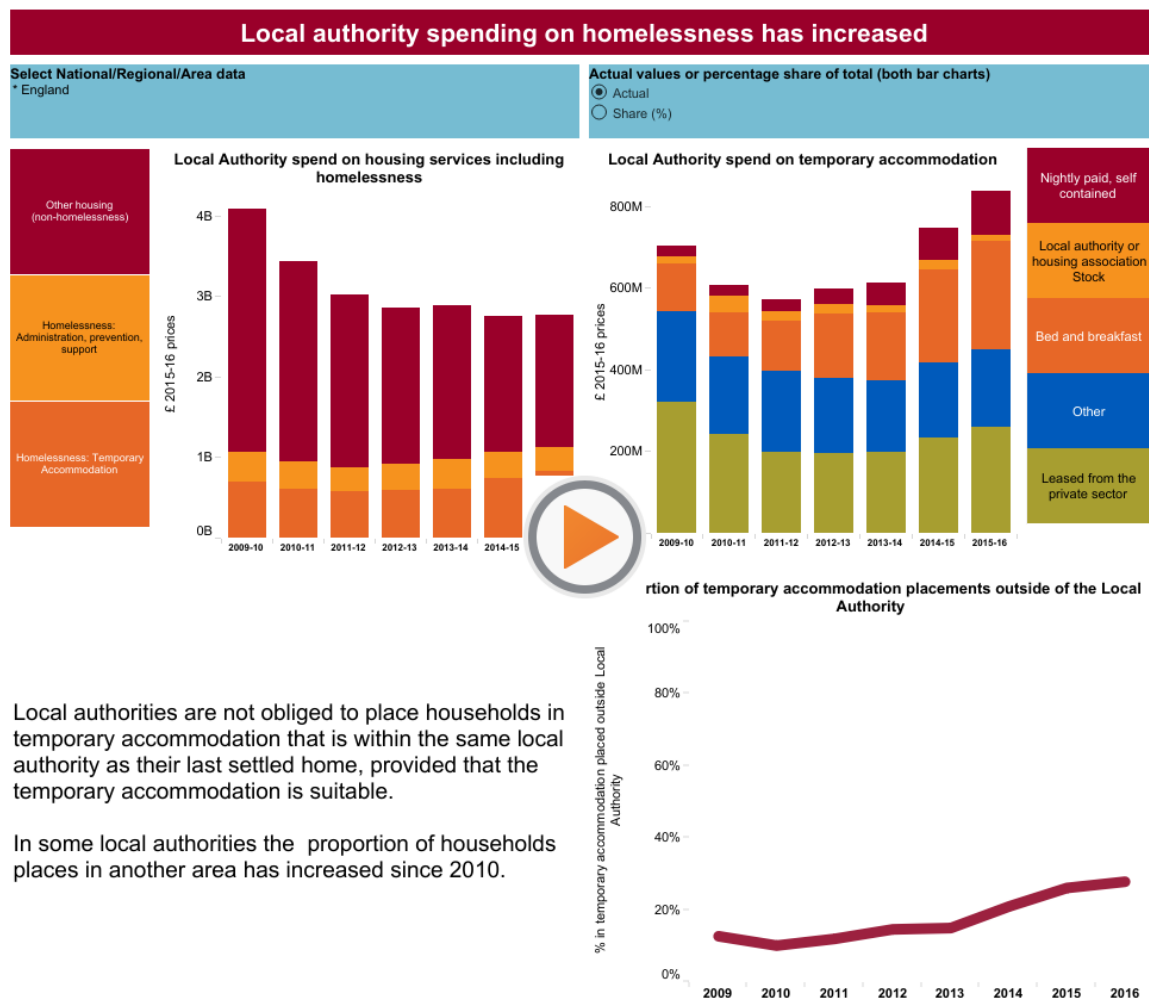
I work mostly in data analysis, that's my background; I have had other roles in the public sector.
(Participant 3C, Authority 3)

Designer

The designer is employed in a larger neighbouring authority, operating between the two organisations and giving a percentage of his contract hours to constructing data visualisations for Authority 3. The visualisations produced enable insights to be gleaned from large or complex data sets. The visualisations are designed so findings can be easily consumed by a variety of audiences, including front-line staff, managers and senior managers. Using Tableau, Authority 3's data visualisation operates using templates already used in a neighbouring partner local authority.

I am a Tableau Zen master, one of only 22 in the world. I go away on retreats to teach others how to use the software. (Participant 3B, Authority 3)

Figure 4.7. Homelessness dashboard 2, National Audit Office (Source: <https://www.nao.org.uk>). Illustrating the type of visualisation dashboards created by designers in this organisation, 2018.



Business intelligence manager

The business intelligence manager is ultimately responsible for mobilising the business intelligence operations at the authority. He has experience in analytics and business intelligence and has previous work experience in the public sector. This is a new role at the authority and it has been created in the past year. It aims to lead on taking the authority forward in terms of how it uses its business intelligence.

The shift we're trying to make is to use business intelligence to add value to the data we have and to help that inform the decision-making processes. So we spend more time looking at what that data means with my colleagues. (Participant 3A)

4.5.10 Roles

Kirk (2016) identifies eight key roles which exist in the production of data visualisation. I will repeat these below.

- Initiator
- Data scientists
- Journalist
- Computer scientists
- Designer
- Communicator
- Project manager

In adopting a post-representational approach to data visualisation, it becomes possible to unpick production, viewing it as a series of decisions made by multiple actors. Data visualisation as a process at Authority 3 is completed and enacted from a team perspective. Individuals are responsible for set roles within the production line. Utilising Kirk's (2016) approach, the role of initiator and project manager is adopted by the business intelligence manager, who is a mainstay in the production of data visualisations and informs the themes and goals of the visuals. They maintain control over the project from a managerial position. They are also responsible for overseeing that the outcomes, quality and time scales of projects are in keeping with the authority's standards. In terms of data analysis, a member of the data team completes the roles of data scientist, computer scientist and journalist. As mentioned previously, the design-based roles (designer and communicator) are completed by a data visualisation specialist and designer at a neighbouring authority, who operates from a specific data visualisation perspective. This means there is no specific discipline which shapes the visualisation. Instead, the visualisation is shaped by a series of key authors and online training platforms for data visualisation. The design and communication elements are completed exclusively in Tableau, using pre-set systems previously created whilst working at the neighbouring authority. Although the role of the communicator is responsible for the extent to which aesthetics affect the way knowledge is transferred through design, they are not themselves responsible for communicating that information to the authority's staff. The project manager communicates to service managers, team leaders and operational staff.

4.5.11 Other stakeholders

The production of data visualisation is influenced by actors from a wider ecology, actors from outside of the authority who play key roles in shaping the visualisations and therefore the knowledge they produce. A longer-term solution is being monitored at present, which has meant creating a relationship with a local neighbouring university. Again, this involves adopting the skills and expertise of MSC computer science students by creating a work-based placement scheme; the authority seeks to trade the experience gained through work experience for the skills and expertise of the students. It is hoped this will become a permanent agreement, with students completing part-time work each semester. The operational capacity of data visualisation is still evolving. They continue to be reliant on the skills of

designers who operate outside of the authority, although the influence of these actors is reducing as the authority becomes able to invest in their own software licenses.

Key stakeholders include:

- Management staff
- Data operatives
- Front-line staff
- The public as volunteer operatives
- University students (as data operatives)
- Local authority partners

4.5.12 Summary

The previous section has addressed the third case study organisation, Authority 3. It began by highlighting the organisation's small size due to its small dependent population. Because of this, they face unique challenges within their operations. In terms of austerity spending measures, this council has a relatively low spend which means it has been able to offset the short- and medium-term effects of austerity. However, a long-term strategy is needed in order to become sustainable in the face of continued spending reduction. Data visualisation is one proposed solution to these problems. In terms of operational procedures, this authority has a small workforce and therefore has sought more creative solutions to filling the skill shortages in staff. They have developed and continue to seek out wider networks of actors who are able to operate at lower costs (discussed further in section 4.6).

4.6 Authority 4

4.6.1 Introduction

The following subsection presents the findings from Authority 4. It aims to give an insight into the particular types of socio-economic challenges facing its residents. These are explored alongside the geographical make-up of the area and the structural organisation of the authority. This aims to portray the issues facing the residents, their reliance on public services and the ability of the authority to deliver those services.

The first subsection (4.5.2) outlines the size and scope of the boundaries of the authority and its urban nature. The second subsection (4.5.3) looks into the make-up of the local population. It highlights indicators of deprivation and explores how these impact upon the expectations of service delivery. Following this, the structure of the organisation is presented on a departmental level. This helps to highlight the scope of the service responsibilities of the authority as a large urban unitary authority.

This is then contextualised by austerity spending measures, which have affected the authority since 2010. It examines the effects that reduced staff size, funding and spending power have had upon an already strained organisation. It concludes by examining the 2018/2019 budget proposals and explores the role of data visualisation as a mechanism for more efficient service delivery. The second half of this section focusses on the production and operational role and production of data visualisation at this Midlands authority.

4.6.2 Geography

This council is located in the West Midlands region of England. The authority can be split into three boroughs, which total approximately 100 km squared. These boroughs can be further split into five key towns in which the authority is located. This organisation represents a medium-sized urban case study and is the second lowest comparable to the rest of the study cases. The Midlands is a unitary authority, one of 55 in England. As such, its services meet the demands of a typical non-metropolitan county council, which will be discussed in more detail in the following section (4.5.3). It has a population of approximately 230,000–270,000 which is spread over approximately 30 wards. These are represented by 44 councillors under a Labour majority. The council is split into 20 Labour, 16 independent and the remainder a mix of Conservative and UKIP candidates. It is a former industrial city, but the services industry now dominates the economy.

4.6.3 History and structure

Authority 4 was founded in 1974 when the LGA (1972) divided England into metropolitan and non-metropolitan councils, of which Authority 4 constitutes the latter. There were initially 296 non-metropolitan counties, which delivered services through a two-tiered structure. It remained in this form until the Local Government Commission for England in 1992. This review began to identify and recommend the creation of single unitary authorities. As such, the Midlands authority was split from its associated county. This meant increasing its responsibilities and taking control over its own services, in keeping with a unitary authority. A summary of a unitary authorities services can be found in the appendix.

In terms of the structure of the Midlands authority, all departments operate under the leadership of the chief executive and senior management team. Operating in the tier beneath that are four key service departments: People, Place, Customer Services and Operations. In addition, a separate fifth department is responsible for public health. Each of these departments has its own management structure which includes directors, managers, team leaders and a team of operational front-line staff who are responsible for an array of service deliveries. The following sections highlight each of these departments, drawing attention to their responsibilities as service providers:

- People
- Places
- Customer Services
- Operations
- Public Health

4.6.4 Demography

The demography of Authority 4 is reflected in the duties of care and priorities of this authority. The changing vulnerabilities of its resident population mean the local authority tailors its services to meet demands. These challenges are heightened through increasing spending cuts and wider issues of deprivation. As mentioned previously, Authority 4 is a rural area which hosts approximately 270,000 people spread over key towns. In terms of the population's age range, 19% are identified as under 15 years old, 21% are over 60 and the remaining 60% are of working age.

There are approximately 40,000 people considered economically inactive. The authority has high levels of unemployment, represented by 2,290 JSA claimants and 15,860 receiving ESA, and 12,000 considered long-term sick (numbers approximated for anonymity). The total student population is 19.1%, which compares negatively to the national average. This is significant as it represents the challenges of the authority to deliver and improve local services in a manner that attracts and retains higher numbers of students. It also reflects the industrial economy of the local population, in which trade skills are favoured over academic pursuits. There are approximately 115,000 residents in employment, which can be broken down into 77,000 full-time and 38,000 part-time. The manufacturing industry is one of the region's largest employers; manufacturing and retail are also prominent.

4.6.5 Deprivation

The local authority also suffers from issues of deprivation. It is ranked in the top 15 most deprived areas in England. Nearly 133,000 people (over half the population) live in areas classified as being among the top 20% most deprived in England. As a result, there are numerous social and economic challenges facing residents, which directly affect the operational application of services of the organisation. The authority is caught between two competing narratives – firstly, continuing to invest and improve services to shake off social issues, and secondly, the other social issues creating further economic challenges in the area – which continues to add to the heightened sense of immediacy rather than long-term strategic investments. In regards to some of the key social determinants of health, child poverty, school readiness and educational attainment, these are all significantly worse compared to the country as a whole. There are also issues of homelessness, employment and unemployment, which again compare negatively to the national picture. There are significant health issues facing the residents, as

there are high levels of teenage conceptions and obesity. Finally, hospital stays for self-harm, along with hospital stays for alcohol-related harm, are also significantly worse than the national picture.

4.6.6 Austerity

In 2012, the authority faced a shortfall of £61m. At this moment, the council began initial reductions of staff numbers, leading to approximately 200 job losses (Corrigan, 2018). In the subsequent years, economic circumstances continued to present challenges. The total losses faced in the last seven years have risen to over £170m. This has meant a fundamental shift in the way the authority delivers services. Moving towards a prevention-focussed ‘early signs’ approach has meant trying to remove socio-economic concerns at the root cause. There is also a push towards efficiency (as seen in other case studies), which has meant a more targeted delivery of services. Data visualisation is the mechanism which is helping to drive this efficiency of service delivery. Despite continued cuts in the past eight years, the 2018/2019 budget paints the picture of a council still cloaked by austerity, and there are further obstacles hindering its ability to meet the needs of its citizens.

In broad terms, this authority is again challenged to create savings, with a further £10.5m being outlined in the 2018/2019 budget (Corrigan, 2018). The losses equate to a reduction of £87 per resident on services. This represents a £7.4m funding reduction from central government, with another estimated £34m by 2020 – the challenges appear daunting. The organisation will again look to create savings by reducing staffing costs, with a further 35 job losses in the coming year. An increased demand in social care is to be offset through further increases in council tax. This will see proposed increases of 4% in this period and a further 3% in the forthcoming year’s budget proposal. This will bring about a real-term increase of £60 per household for the majority of residents.

The council’s approach to homelessness is under review. In 2012, it was a point of pride amongst the heads of council when such services were protected, as outlined in the passage below:

We don’t have to provide these services, but we have continued to do so because we think it’s the right thing to do for our citizens. (Local councillor A) (Woodhouse, 2017)

The review in 2018/2019 has reverted to only funding statutory obligations towards homeless citizens, which seeks to create savings of £316,000. In keeping with their statutory mandate, the council will cease funding HIV care and support services by 2018/2019 to secure a further £124,000 in savings. Efficiencies made to stop smoking support services will also generate £190,000 in savings. A review into land owned by the council is said to present an increase in income through car parking of £200,000.

Key savings:

- £2.5m raised by building new homes
- Review of adult social care packages and a reduction in services of £2.4m
- Reduction in children's care of £1.29m
- Reduction in drug and alcohol services of £135,000, rising to over £750,000 in the next two years
- School nursing reductions of £287,000

The previous section has shed light on the financial challenges which have engulfed service delivery at the Midlands authority in recent times. Mounting socio-economic pressures have forced numerous shifts in its strategic design. As Participant 4A from the performance team at Authority 4 states:

We have had eight chief execs in eight years. Each of them bring about their own set of ideas and principles on how to deliver cost effective services. (Participant 4A)

Currently the authority seeks to offset continued austerity spending measures by becoming more targeted and efficient in its decision-making and service delivery. Data visualisation is the mechanism which enables these changes. The processes of its production are to be discussed in the following sections.

4.6.7 Data visualisation at Authority 4

As set out in the previous sections of this chapter, this local authority delivers a wide range of services and is responsible for understanding and meeting the needs of its residents. Its use of data visualisation comes from a performance perspective. Data visualisation is the mechanism for understanding the causes and effects of mitigating factors which affect service delivery. Primarily, it focusses on how to provide more depth and more immediate insight into how services and resources are utilised in the city. There has been a culture shift in moving away from what are considered to be reactionary targets, instead understanding quarterly and annual targets in terms of not just what has improved or decreased but why things have changed. Within this Places department there is a performance team whose focus it is to create and utilise data visualisation in this local authority. This department covers services such as city performance, economic development, city regeneration, housing, planning and homelessness, culture and heritage. There is a culture of education within the department. They hope to improve awareness of the benefits of presenting data visually by internally upskilling staff through training sessions on visualisation and statistics. There is more of an emphasis on front-line staff being responsible for their own work in the future.

4.6.8 Processes

The data visualisation production within this organisation can be split between two workflows of production. The first is the most prominent: performance insight. With this, the ideas germinate from

operational staff and team leaders and managers within the department. These are then forwarded to the performance team, and it is their task to conduct the data analysis and to create a visualisation that best communicates the information to the required audience. These visualisations are then communicated back to the initial point of contact. Once the information is absorbed and digested, the unfolding practices begin (as discussed in Chapter 5). The second workflow involves operatives from within the Places mandate completing the whole of the process themselves. This involves raising a query, collecting, cleansing and shaping the data, before visualising that to communicate it to an audience. This is still a new process within the authority. This is only available to staff who have been accredited through internal training, which aims to bring a consistent approach to data visualisation at the authority.

The data used in this authority is a mix between primary and secondary data. The latter is divided into two categories: publicly available open data is used and interwoven with primary data at the authority and data which has been purchased. A key example of this is public aggregation data, which is used to supplement performance statistics. This is purchased on subscription from a credit check agency (Experian).

4.6.9 Actors

Performance team

These members of staff are responsible for the analysis and communication of data within the Places directorate. They operate under the same management structure as the rest of the department. They work in targets and performance, which means they frequently and directly report to the councillors and senior management team. The work conducted by these members is also completed within the frameworks, guides and processes of the research governance panel.

Places front-line staff

Front-line staff are responsible for liaising with the performance team in order to get the required insights from data regarding their own projects. They do so by sourcing or identifying data sets and highlighting key queries which are to be further investigated. These are then discussed with the performance team, who begin to take ownership of the project at that point. Initially, they lacked experience in data visualisation, but they had an in-depth of understanding of the issues in their particular field of work. Increasingly they are becoming mobilised as producers of visualisations through internal training and guidance. They have their own deadlines and line management, but are reliant on the expertise of the performance team; therefore, a relationship of trust exists between both parties.

Designers

The design team is responsible for graphic design in the Places directorate; their role includes a wide range of design-based tasks. They are also involved in the production of data visualisation for public-facing reports and those which are used in marketing campaigns. As they are considered experts within the department, they are afforded creative freedom in the design.

4.6.10 Roles

Initiator

The role of the initiator, in this case, lies in the hands of the individual. In all workflows highlighted in the previous section, the initiator is responsible for setting the research agenda of the data analysis, in the form of a FOI request, either from the public or through a query which is then passed to the performance team, or through setting out a research agenda which is then actioned and followed through by an individual operative.

Data scientist and computer scientist

These roles are conducted primarily in the performance team. Each operative within this team has a background in statistics and data analysis. This is reflected in the aesthetic design of the data visualisations, which are orientated and framed around the most effective and efficient method of presenting data (Few, 2004). When creating data visualisations which are for public documents, the role of the data scientist and computer scientist is somewhat negated in exchange for more eye-catching, attention-grabbing visuals. In this approach, creative freedom is given to the design team.

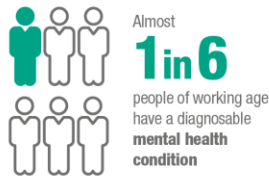
Designer

The directorate has three designers. Despite having their individual strengths, they operate generally to demand. They cover a wide range of duties, including creating infographics and illustrations. They also work on data visualisations for key internal and external documents, such as performance or public reports. They all primarily operate from the perspectives of ICT and graphic design. They are more recently becoming increasingly exposed to data visualisation in their role and as such have continued their self-development in these areas. They are keen to emphasise ‘creativity’ as a defining feature of their skills and products.

Having an eye for what the public want. (Participant 4D, designer)

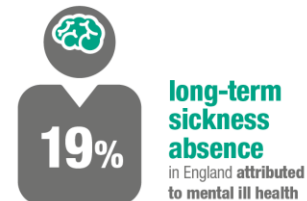
Figure 4.8. Public Health England, mental health (Source: <https://www.gov.uk/>). An example of the graphic design-based visualisations being created in this organisation, 2016.

Health and Work Spotlight on Mental Health



In 2015, some **48%** of **Employment and Support Allowance recipients** had a 'Mental or Behavioural disorder' as their primary condition

Each year mental ill-health costs the economy an estimated **£70bn** through lost productivity, social benefits and health care.

Of people with physical long term conditions, **1 in 3** also have mental illness, most often depression or anxiety

Work can be a cause of stress and common mental health problems: in 2014/15 **9.9m** days were lost to **work-related stress, depression or anxiety**



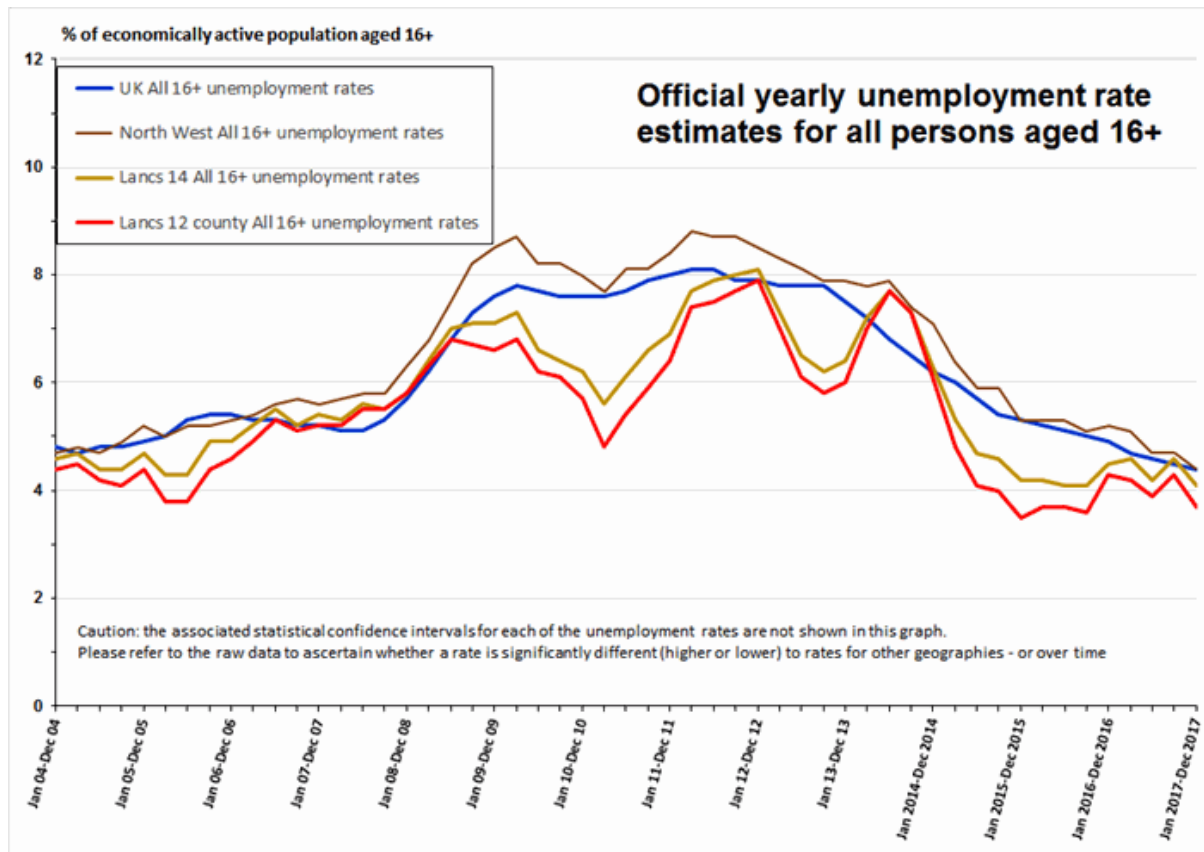
In 2016, **42.7%** employment rate for those who report mental illness as their main health problem (Mental illness, phobia, panics, nervous disorders (including depression, bad nerves or anxiety). **Compared to 74% of all population**

Sources: Adult Psychiatric Morbidity in England, 2007; Health and wellbeing at work: a survey of employees, 2014; Cimpean & Drake 2011; Naylor et al 2012; OECD, 2014; Labour Force Survey, various years

In terms of the performance team, the design role is mediated by a best graph for purpose. This stems from a scientific approach (adopted from computer science and data analysis), in which the aesthetic of the visualisation must be fit for purpose in the most efficient and effective display (Few, 2004).

I want to show the must amount of information in the most simple way. (Participant 4D)

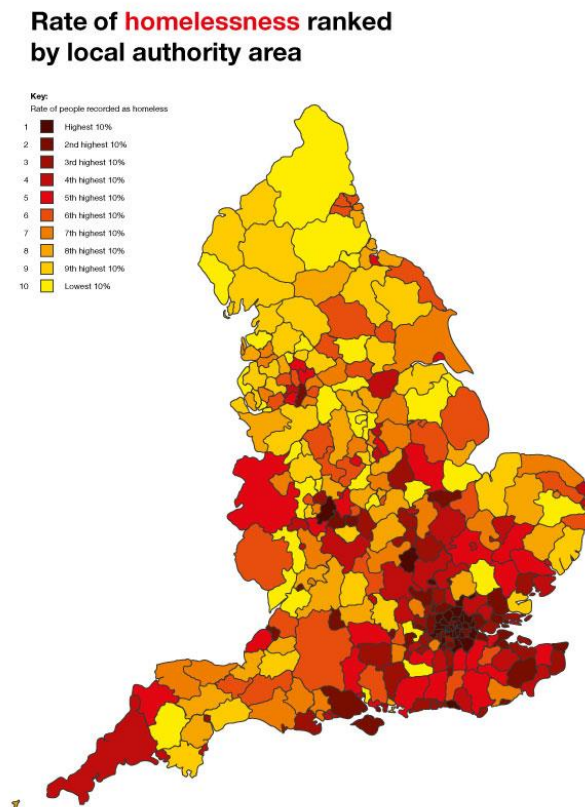
Figure 4.9. Unemployment in Lancashire (Source: <http://www3.lancashire.gov.uk>). An example of the types of data visualisation completed in the performance team, 2015.



The directorate has a GIS and mapping specialist who operates from the economic development team and has previously worked in insight roles, and therefore continues to operate as an ad hoc expert on GIS and mapping for the performance team.

We used to have a GIS team, but now there are fewer and fewer people who do mapping. I'm one of the only ones left; I get work from every department about GIS. (Participant 4E)

Figure 4.10. National homelessness t (Source: <https://england.shelter.org.uk/>). An example of the types of mapping work completed in this organisation, 2018.



Communicator

The communicator in this authority is responsible for understanding the needs of the project to ensure that the visualisation is understood by the intended audience. Key points need to be absorbed quickly and easily by consumers in order to ensure that they are acted upon operationally. The complexity and familiarity of the visualisation are key responsibilities for the communicator. This role is performed by the data and computer scientist, who continues the development of the data into its final visual form. In this workflow, they have to take design decisions based on the intended audience's abilities, utilising frameworks of best practice. At this authority, the role of the communicator is then transferred to project 'initiator', who contributes by addressing whether the visualisation is in keeping with the original needs of the project.

Project manager

The role of the project manager, as Kirk (2017) describes it, is to oversee the logistics and quality of a project. In this authority, this role is split between numerous actors. As for ensuring the logistics, deadlines and aims of the project are met, this role is co-opted by the ‘initiator’ and the ‘data scientist’. Although the initiator will have their own deadlines and aims for the project, the data scientist, as an expert, is able to present their own interpretation of this process to ensure that the final project’s aims are both realistic and achievable. The second position of the project manager is in relation to quality. This is conducted by the research and governance panel, who are responsible for quality control of the organisation’s data collection and output. Although they do not directly communicate with every project, their presence is felt through training, guidelines and review.

Journalist

The role of the journalist is neglected in this authority’s working processes. Data science and computer science play an important role in influencing and shaping how the operatives view data and visualisation. There is less emphasis on investigating a particular singular narrative. Instead, data is used to supplement understanding of many parts of the whole operational processes.

4.6.11 Summary

The previous section has discussed the final chosen case study, Authority 4. It began by addressing the geographical and structural differences of this authority – notably its large urban geography, high dependent population and high levels of deprivation – which provide an alternative version of a non-metropolitan council. The total losses faced in the last seven years have risen to over £170m. This has meant a fundamental shift in the way the authority delivers services. Moving towards a prevention-focussed ‘early signs’ approach has meant trying to remove socio-economic concerns at the root cause. There is also a push towards efficiency (as seen in other case studies), which has meant a more targeted delivery of services. Data visualisation is the mechanism which is helping to drive this efficiency of service delivery. This section then explored the production of data visualisation at this organisation, drawing comparisons with the operational practices and the work of Kirk (2016), and the required roles needed in data visualisation creation.

4.7 Processes of production

The previous subsections of this chapter have discussed in-depth the functional and organisational differences between each of the individual local authority case studies. It has also explored the factors of production at each of the case study organisations. The following section presents an account of the

processes of production and working practices, which are both common and unique across each of the cases, critically inspecting the benefits and challenges of each.

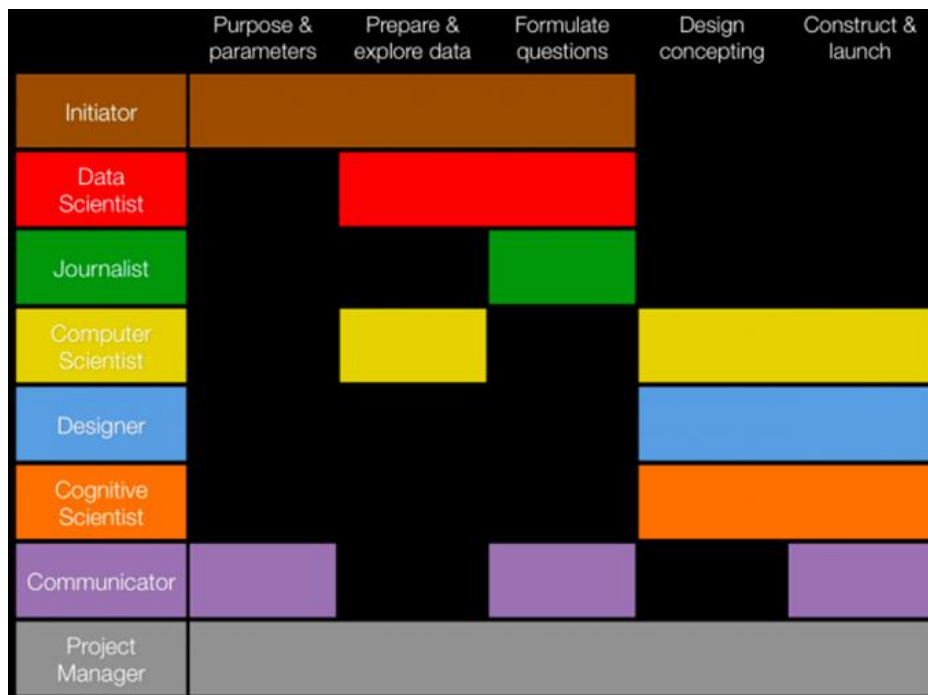
The following subsections begin by first drawing attention to Kirk's (2017) eight roles of data visualisation production (see also section 2.2) and expands upon those ideas within a local authority context to include the role of 'trendsetters', who influence data visualisation practice. The second subsection (4.6.2) highlights the structural and economic drivers of data visualisation production. Section 4.6.4 explores the differing networks of actors and intermediaries within data visualisation production in each of the case studies and illustrates economic constraints on data visualisation production and the solutions enacted. The following subsections focus on the role of data within the production process – firstly (4.6.4), by highlighting the sources of data which are utilised at the case studies, and secondly (4.6.5), exploring the importance of data literacy. The final subsection (4.6.7) illustrates the particular design strategies as implemented within the local authority case studies, focussing on the challenges of audience engagement and the constraints of producing data visualisations within the local authority case studies.

4.7.1 Roles

Kirk (2017) describes the eight roles a data visualisation creator can adopt to account for the interdisciplinary practice of the discipline. I will again readdress these roles below:

- Initiator
- Data scientist
- Journalist
- Computer scientist
- Designer
- Cognitive scientist
- Communicator
- Project manager

Figure 4.11. Kirk's roles of production, 2015 (Source: <http://www.visualisingdata.com>).



Having discussed the roles in relation to each of the authority cases in the previous sections of this chapter, I would propose the addition of a further element to this pathway of production. There is an overarching influence from key leaders in the field who influence the designers at each of the local authority case studies. This is significant, as they produce key handbooks and guidelines which then shape the creations, the insights and the eventual decision-making. The more graphic design-focussed individuals tend to consider themselves as creatives, incorporating a variety of design-based influences. As noted by Participant 4C, a designer from Authority 4:

I get influenced by lots of things, not just the data viz stuff. I'm looking at graphic design, art, and architecture. (Participant 4C)

This contrasts with those who are rooted in a scientific background, as Participant 1D, a computer scientist and an associate of Authority 1, describes:

I come from a scientific background so that's how I explore data; the visualisation is the way I present those findings to an audience. So I work to simple, efficient designs, think Tufte. (Participant 1D)

In the above quote, the participant refers to the Tufte's (1983) ink-to-data ratio, which was discussed in section 2.3. However, there is also a third group which operates specifically from within the field of

data visualisation –non-academic practitioners – and as such they are less concerned with theory and are focussed on developing their practical skills. These practitioners take inspiration from the online community, from the developing networks of data visualisation practitioners, as well as a few notable key texts, a point summarised by Participant 3B, a designer at Authority 3:

I mostly use Tableau, so I learn a lot from their online training; they also have a forum for users to share ideas, and also Twitter. Then there's the stuff everyone reads, Kirk etc. (Participant 3B)

It is not just about the influence of field leaders in developing work themselves; they are also integral to drawing attention to other works that they consider valuable, linking actors together across social media platforms. Participant 5B (a freelance data visualisation practitioner and host of a data visualisation-specific podcast) describes the significance of key actors below:

There are a lot of people doing interesting work that maybe don't get much attention, but then there's also the rock stars, think Andy Kirk, Alberto Cairo. I know if I get them on the podcast, the numbers are great. But that's why I always try and use the platform to bring attention to other things [...] We all have a responsibility within the community to use our platforms to highlight other people – that's how you develop a field. (Participant 5B)

Here the participant recognises the influence of the field leaders in shaping the debates. These actors are integral to creating new developments themselves, but also linking new works and using their position to draw a much larger gaze upon developments they consider valuable.

4.7.2 Drivers

This subsection will examine the context in which data visualisation has become a more prominent feature of local authority communication, policy development and service delivery. It will highlight examples of the types of contexts that have driven the demand for a more nuanced approach to data visualisation and which can be identified in three main approaches: structural, economic and policy-based. The last two years have seen a rapid acceleration in the application of data visualisation, 'largely due to the economic pressure and the tech hype cycle, and by 2020 local authorities will need to be good with data' (Participant 5D, data visualisation professional). This draws attention to the need for local authorities to ensure that new skills and techniques are understood and that staff are able to fluently speak the language of data. Whilst some local authorities are taking more tentative steps, others have flourished and moved at a much more accelerated pace. The following draws upon selected case studies to provide an understanding of the processes and drivers that help to accelerate the interaction between data and data visualisations.

Policy drivers

Policy decisions on both the national and local authority levels were cited as an important factor in the drive towards a more robust data strategy, in which local authorities are using data visualisations to both analyse and communicate their data. As a starting point, the drive for transparency and the increasing frequency of freedom of information requests were cited by numerous participants as being a key catalyst in the development of data visualisation strategies. As identified by Participant 1A (data lead at Authority 1):

We had ridiculous amounts of data [...] Lots of information, locked in different systems that don't talk to each other. (Participant 1A)

The participants then focussed their attention on unlocking the potential of that data and on improving their efforts to communicate it in more effective and engaging ways, with the aid of visualisation techniques.

It was basically a publication scheme [...] what I noticed is that what we were publishing wasn't really important to people. I tried to get those out the way and focus on something that might be more interesting. (Participant 1A, data lead at Authority 1).

Participant 4A of the Authority 4 performance team also states:

They need to reflect the problems on a grassroots level, otherwise people won't be interested. (Participant 4A)

Increased access to data and a more in-depth understanding of the types of data that were available became the platform from which to investigate alternative ways of working. Participant 1A, a data lead in Authority 1, embraced the changes to a more data-orientated approach:

There is no reason we can't be a very forward-thinking organisation. (Participant 1A)

This change in approach is also highlighted by Authority 4, who have moved away from 'ubiquitous long-term targets' and instead utilise data visualisations to provide short-term 'evidence-based results from the top down' (Participant 4A, data scientist and manager in the performance team). In so doing, they provide a 'holistic impression of the area' (Participant 4B, a computer scientist in the performance team).

Structural drivers

The changing political landscape and the need to make huge cuts have left many local authorities searching for alternative ways of working. Staff reductions, merging departments and a change in the management structure all impact upon working directives.

We are currently operating with a senior management team and the level below that was probably less than half of what it was even three or four years ago. (Participant 3B, data scientist and communicator, Authority 3)

These changes have affected the operations and working practice in two ways. The first is a change in direction and philosophy from the top down. Participant 4B (Authority 4 performance team) identifies the structural changes encountered at Authority 4 and its impact on working practices:

We've had about six or seven chief execs in the last eight years [...] I have worked with five different chief execs, all different styles. The former wanted everything in dashboards, red, amber, green targets – that's all gone now. (Participant 4B)

Figure 4.12. Children and Families performance in Norwich. An example of the use of Red, Amber, Green (RAG) targets in data visualisations, 2018 (Source: <https://cmis.norwich.gov.uk>).

Children and Families Performance FY2018/19 Q1									
	Latest update	Current Performance	Better or worse than previous data point ^A	Trend Charts	Status RAG	National benchmark (quartile 1 = Neighbour top)	Most recent Statistical average		
Children at most risk are protected from harm and kept safe									
% child protection cases which were reviewed within timescales.	Q1	95.8% (250)	Similar		G		2	89.9%	
% of children becoming subject to a child protection plan for second or subsequent time	Q1	12% (15)	Better		G		1	20.8%	
% re-referrals to childrens Social Care within 12 months	Q1	29.0%	New		R		4	24.1%	
% Continuous assessments completed within 45 days	Q1	76.0%	New		A		3	82.0%	
% of Child Protection plans lasting 2 years or more open at the end of the quarter (low = good)	Q1	0.5% (2)	Better		G		1	1.8%	
Placement stability - % children with 3 or more placements during a year (low = good)	Q1	8.3% (48)	Higher		G		2	12.4%	
Placement stability - % children in same placement for 2+ years or placed for adoption	Q1	69.1% (103)	Better		A		3	68.0%	
% of Care Leavers in suitable accommodation (end of quarter)	Q1	92.1% (35)	Similar		G		1	80.8%	
The % of Care leavers in education, employment and training (EET) (end of quarter)	Q1	55.3% (21)	Better		A		2	48.1%	
CSE referrals	Q1	81	Higher - no polarity		n/a	n/a		n/a	

This process was also cited as a factor in Authority 2, with Participant 2A (a data scientist and communicator at Authority 2) suggesting that:

with each change at the top comes a new idea, strategy [...] I've been brought to this LA recently due to my background in business intelligence as part of a program of restructuring. (Participant 2A)

These changes are symptomatic of the wider shift in thinking within local authorities; a drive towards a more data-focussed strategy is seen as a remedy to a reduction in staff sizes. The second instance in which these changes have impacted the production of data visualisation is somewhat more organic. Participant 4D (a communicator at Authority 4) suggested that, as staff sizes are reduced, departments are merged and there is 'a certain amount of workload spill-over'. In Authority 1, this led to changes, as staff from the business team became more involved in projects from other areas to try to mobilise organisation-wide data analysis.

I approached my boss saying, look, this is what I can do and this is how I think it can benefit us [...] I am lucky that I had a significant amount of good will from those higher up in the council. (Participant 1A, project manager at Authority 1)

Economic drivers

The increasing economic pressure has left local authorities facing challenging times; it is therefore out of necessity that authorities have had to explore alternative means of service delivery.

It has become impossible to continually salami-slice away services. Business as usual is simply no longer an option, it's adapt or face switching them off altogether. (Participant 5E, local government think tank)

Currently, local authorities are trying to 'do more with less' (Participant 1C, Authority 1 associate), and the only way this can be achieved is to 'make much more efficient use of the people they have' (Participant 1B, Authority 1 associate). Therefore, one of the proposed solutions, and perhaps the most commonly applied, is to 'make smarter use of data' (Participant 2A, Authority 2). However, participants were keen to highlight that any shift in strategic thinking has to be considered within a sustainable, long-term business model, as: 'Without one it won't be maintained and won't provide any value in the future' (Participant 1C, computer scientist at Authority 1).

4.7.3 Networks

The local authority cases utilised different networks of actors in the production of data visualization. Authority 2 and Authority 4 operations were kept in-house, with a specific team and designers. The remaining two cases faced more challenging circumstances to gain the expertise of data visualisation creators. In Authority 3, all of the design work is conducted at a neighbouring local authority, as they

lack the software licenses and are unable to invest in staff. The larger neighbouring authority already employs a data visualisation expert. Operationally, this means that the working templates have already been created and the designer uses existing formats, replacing the existing data files with those of Authority 3. As Participant 3B (a data scientist and communicator) states:

I work primarily in another organisation but I also do the data viz for them (as a designer at Authority 3). I work with Tableau already, so I just use the same templates. It's just a case of, OK, so you have social care data, what did I use for that last time? OK, drop in the new data. (Participant 3B)

Authority 3 is also seeking out alternative means of keeping data visualisation production in-house. They are currently collaborating with a local university to offer work-based placements for students. Participant 3A (a project manager of Authority 3) describes this below:

There is a possibility of a student on that Master's course doing his project here with us, starting in May this year. So again, that is about trying to set up a local partnership with academia. The student will get something from it as they have links with a local employer and local business, and they have a student who can do a meaningful project which can make a big difference, and they can get some work experience. (Participant 3A)

Again, this is due to the lack of investment in data visualisation within the organisation. However, Participant 1A (a project manager) is hopeful that this is only a temporary measure and that by demonstrating the value of data visualisation, this will lead to further investment.

Hopefully when we move forward we can demonstrate the value of that and get further investment and use of that type of business intelligence tools going forward. (Participant 1A)

At Authority 1, they employ data visualisation practitioners on a temporary basis, as and when. Again, this is due to financial constraints; it highlights the desire of the organisation to increase engagement with data visualisation, but they have not yet got the working practice to make full-time permanent employment viable. As Participant 1D (a data scientist and communicator) highlights:

I am not employed directly, but I do small pieces of work from time to time. The projects are very varied, but I do enjoy collaborating with them. (Participant 1D)

4.7.4 Data sources

As discussed in the literature review (section 2.3), data is considered the foundation of any visualisation. However, its role in the visualisation process must be considered critically – from within the local authority case studies, there are varying interpretations and assumptions of data as objective. There were three main sources of data for all the case study authorities. The primary data was most commonly gathered from in-house surveys which were distributed to local citizens, although this method was criticised for being too time-consuming and expensive. Participant 2B (a communicator at Authority 2) felt like the authority still had fundamental design issues to address:

It's good to collect primary data, but sometimes it's counter-productive. It needs to be more streamlined. We have lots of different departments creating questionnaires and the results aren't usually shared [...] We also don't all have the same background, so there is a lot of variables in design and quality. (Participant 2B)

The above quote highlights some of the potential issues facing authorities. Given the size of local authorities and the scope of services they deliver, on an organisation-wide basis it appears difficult to gain any cohesion or structure. This occurred across all four of the cases and was acknowledged as a common issue. The only case which attempted to bring structure and cohesion to its research was Authority 4 (which will be discussed further in section 4.6.5).

The second source of data in the local authority case studies was 'purchased' data. This comes from a number of sources; the most prominent example of this is through credit reference agency Experian, whose product Mosaic was frequently cited as a means of profiling the local population. In the following quote, Participant 4B (a computer scientist from Authority 4) introduces and describes Mosaic:

So then over a period of time developed products like Mosaic, which is a geodemographic profiling tool. That actually profiles every household in the country, 25 million households. If you think about it as the world's largest spreadsheet, they got about 3,000 different characteristics on each household. They aggregate some of that information to come up with about 15 generic Mosaic types and 15 generic Mosaic groups. (Participant 4B)

This product is purchased on a monthly subscription and is used across the case study organisations. When we consider the assumptions of data, Kitchin (2014) suggests that we must consider the purpose the data was initially collected for, and to recognise that data should not be assumed to answer all questions. The Mosaic data package uses its own variables of primary information, but also relies on purchasing other data to create a holistic impression, before aggregating scores to provide a geographic representation. Despite recognition of these factors, there appears to be an over-reliance on the package.

Participants appeared to consider it more truthful than their primary data – a point summarised by Participant 2B, a communicator from Authority 2:

They [Mosaic] also commissioned their own research, but they also buy into stuff that everyone else does. So they have a really fantastic data, everything from your car insurance, house insurance, travel insurance, your buying patterns, your income, it covers everything. (Participant 2B)

The above quote offers an example of the way data carries assumed objectivity. By purchasing data, the participants appear to recognise it as being more truthful and accurate than their own, perhaps because they have been removed from the gathering process themselves. Alternatively, the scale of the Mosaic package and its many variables give the data the perception of ‘seeing everything’. Despite placing value on the scale of the package, when asked, participants across authorities only spoke of the credit variables, suggesting that little attention is paid to the individual variables themselves. This highlights that the sheer scale of the package promotes an uncritical eye, without questioning the methods by which this data was collected, by whom or for what initial intended purposes. Further, in Authority 3 there were economic barriers to purchasing the correct data. Participant 3A described how the process of creating monthly dashboards of progress was hampered by the organisation’s choice of which data to purchase:

Our partners wanted to show it in months, but the data we buy for this doesn’t have that option so we have had to use a proxy measure for this one. (Participant 3A, project manager)

This highlights the reliance on purchased data for authorities to be able to deliver on their data strategies. However, the above quote also offers an illustration of Taylor’s (2014) notion of critical data, that data does not exist independently of the tools, technology and techniques which created it.

The third data source operationalised by the local authority case studies was open-source data. The local authority organisations mostly used government organisations for their open data sources. Organisations such as Public Health England were credited as being useful. However, some participants remained sceptical of the quality of national open-source data. As Participant 2B (a communicator) states:

National data is just as inaccurate as local data and I’ve got countless examples of tools where the data is wrong. (Participant 2B)

Although operating on a much larger scale, the issues are the same as those cited on a local or organisational scale, which offers an insight into a much larger, national organisational problem with data literacy. In terms of expanding the networks of shared and open data, only Authority 1 referenced it as a potential opportunity for increasing collaboration and improving services across the city. Participant 1A, the data lead of Authority 1, describes the ambitions of the organisation in the quote below:

The third sector has been a little guarded with us so far. What I hope is that eventually we all see that if we work together, if we share data and information, we will improve the city [...] the main drawback so far is private sector, they won't share anything with us – for example, data on buses would be great to be able to tailor city services to events, etc. (Participant 1A)

4.7.5 Data literacy and rigour

Data plays an integral role by not only initiating an enquiry and search for knowledge, but also acting as the foundation and bedrock from which the eventual data visualisation is built. The following subsection considers how data is understood in practice within local authorities. It is important to understand the working processes involved in utilising data in this environment. Data is often considered to be the starting point in the production of data visualisation: '[The] first step for me is usually looking for data' (Participant 1C, computer scientist at Authority 1). Following this, participants often referred to spending time:

Interviewing the data or trying to get the data in shape [...] looking at the source and credibility and the accuracy and reliability [...] What issues can it inform? Will it remain internal? Can it go public? (Participant 3B, designer and data scientist, Authority 3)

Throughout the data visualisation community, these ideas appear to be commonly accepted. Participant 5A, a data visualisation practitioner and academic, states:

It's absolutely necessary to investigate the data itself, you have to know a lot about the data, how it was collected and so on [...] There could be flaws, spreadsheet errors or a typo, or something less tangible such as bias, intentional or not. (Participant 5C, data visualisation expert and academic)

The significance of this is that it helps to spot and remove flaws, which ultimately damage the credibility and legitimacy of the visualisation. The above quotes highlight the importance placed on working with the data, which is in keeping with the pathways of production outlined in Chapter 2 (Kirk, 2016;

Evergreen, 2017). Whilst participants recognise this as an integral stage of creation, there appear to be varied levels of data literacy within organisations.

The hard bit is in the organisation, to change awareness and appreciation of good quality data. (Participant 3D, chair of the research and governance panel at Authority 4)

Only one case study was actively moving towards internal scrutiny, training and regulation with regards to data literacy. In Authority 4, staff from all departments were offered in-house training to improve data literacy. Having experienced difficulties within his own department's use of incorrect and incoherent data, Participant 3D proposed a research governance panel whose objective it is to apply scientific rigour to everyday working practices with data and data visualisation.

Trying to introduce a base level of academic rigour into the department, so if we get to the end point with good-quality data, we have no concerns of its accuracy. (Participant 4D, chair of the research and governance panel, Authority 4)

The panel also contributes to the development of in-house training for all departments to raise awareness and improve the performance of how data is understood and the potential issues. However, the biggest constraint did not appear to be knowledge or understanding, but rather an issue of confidence. Many staff members appeared to recognise how to inspect data, but often knowingly accepted mistakes, which again highlights the challenges of interpreting data through assumed objectivity.

You've got to be very confident and say, actually, that's a load of rubbish. (Participant 4B, computer scientist, Authority 4)

Despite the introduction of the research and governance panel, the roll-out of formalised training and the primary data collection committee, Participant 3B (performance team, Authority 4) recognises that there is still a long way to go before Authority 4 can be considered successful in its approach to data:

We want to keep building more and more, but ultimately to try and get that spread throughout the whole organisation. (Participant 3B)

The importance of maintaining and delivering a high standard of service delivery and insight appears to be lower on the list of current priorities. Participant 3C from Authority 4 gives an insight into the way data literacy and skills are considered a nuisance rather than a mandatory practice:

The challenge for me is to do as much as I can without getting sacked. (Participant 3C)

This quote ties into wider attitudinal problems within local authorities. In Authority 3, the data lead also described how his proposed benefits of data insight were greeted with less than optimistic responses:

It was seen as that would be great but [...] like the icing on the cake [...] as an addition to how we already work rather than the way. (Participant 3A)

4.7.6 Design strategies

In the data journalist approach, designers aim to find the story within the data. In treating the process as a story, emphasis must be placed on following a ‘particular narrative or punchline’ (Participant 5A data visualisation researcher), finding what is striking or interesting and using that message as the focal point of visualisation. This approach is important, as the designer becomes responsible for unpicking which truths to reveal, which can often come at the expense of others (D’Ignazio, 2017).

Being accurate with data and trusting its sources are ways of ensuring that you have created a visualisation which reflects the professional standards of the field (discussed in more depth in section 2.3). Participants raised awareness of the importance of maintaining ethical standards.

Ensuring that at the minimum it is accurate [...] your own integrity is key. (Participant 1C, computer scientist, Authority 1)

This highlights the role of the designer in producing knowledge and releasing it into the world; in doing so, they must be mindful of their own positionality and stature, and the potential power relationships which they are complicit in recreating (these ideas are discussed further in section 5.5).

Different audiences

Whilst other fields of data visualisation may be able to target their work towards a specific audience, data visualisation practitioners at the case study organisations cited issues with the much larger and more diverse audience with whom they communicated. One of the main critiques of local authority data visualisation was that creators had not been inclusive to the abilities of their audience. Participant 5B (subject expert) suggests that the best way to promote improved data visualisation is to ‘pay more attention to the project’s goals in relation to the audience’.

However, within the local authority setting, these processes and questions are much more complex and contested. In Authority 2, the structure of organisations has meant that it is not so much a question of knowing your audience as an individual, but understanding the variabilities and scope of potential audiences. Participant 2B (a communicator at Authority 2) describes this process as:

Designing for multiple distinct audiences at the same time [...] We can be representing three or four organisations or departments [...] we need to make sure we meet their needs. (Participant 2B)

The political nature of local authorities means that inevitably there is a certain amount of self-preservation and almost a fear of backlash, with one participant warning to ‘always be wary of the audience’ (Participant 3B, a data scientist at Authority 4), whilst simultaneously understanding the need for data visualisations to be compelling and coercive from the outset, by considering ‘How to get them to agree to or buy in to the statement. Get folks interested and encourage them to explore’ (Participant 1A, data lead at Authority 1). These issues draw initial focus to the role of beauty in attracting attention, drawing curiosity and promoting investigation, which will be discussed in more depth in the following chapter (section 5.6). The challenges associated with designing for multiple audiences are again discussed in the analysis chapter of this thesis (see section 5.2).

Constraints

Perhaps the most prominent tension is the implications of time and deadlines, which perpetually loom over the departments, designers and councillors. This means that, within the processes of production of data visualisation, designers are consistently subjected to the forces and influences of working in a high-pressure environment, compounded by support staff and line managers lacking the required understanding needed to maximise the benefits of data visualisations.

There’s usually unrealistic deadlines, senior managers have virtually no concept of the time it takes to do data analysis and create a data viz. (Participant 2A, data scientist, Authority 2)

This is a point emphasised by Participant 3B, a data scientist and designer at Authority 4:

I’ve been asked to turn around documents in a day [...] you just buckle down and try. (Participant 3B)

One perspective on this issue relates to the recent surge in the popularity of data visualisations. Within mainstream news and social media, they are becoming increasingly desirable, although this appears be value added for their aesthetic appeal rather than their contribution to insight or communication.

They are hastily added to documents as second thoughts. (Participant 2B, project manager and communicator, Authority 2)

In addition, as all case study organisations are in some way still in transition in terms of their operational interactions with data visualisation, they are adjusting to new ways of working. In Authority 2, the purchase of new data visualisation software has added to the expectation that visualisation creation is an instantaneous process.

I have been asked on many occasions to produce urgent work in a matter of hours which would literally take several weeks to do properly. (Participant 2A, data scientist, Authority 2)

This issue is not an exclusive problem, as shown by the following quote from Participant 3B, a communicator at Authority 3:

The most successful projects I have delivered have taken months of work. Even then, senior management struggle to understand why it was taking so long. (Participant 3B)

This quote highlights that perhaps there are conflicting views of what constitutes a successful data visualisation. It illustrates that senior management may not value data visualisation as an object for analysis or communication, and consider it much more as an accompanying aesthetic document. The effects of these unrealistic deadlines have reoccurred throughout the research process and have become a key tension in the design phase, and as such directly influence the aesthetic outcome and message of data visualisation. The frustrations felt by the designers working in these conditions are illustrated by Participant 1C, a computer scientist at Authority 1, who states:

We all wish we could have time to refine work [...] There was not a lot of time for design decisions, ultimately it wasn't that successful. (Participant 1C)

Again, this highlights the difference in understanding of the role of data visualisation within the local authority setting. Despite increased engagement and investment in software and skilled staff, there remain problems in creating a joint framework between departments for how best to make the most of data visualisation.

4.8. Summary

This chapter has presented three key sets of findings on local authorities in England. The first section addressed the initial broad scoping survey which was distributed to every local authority in England. In

total there were 81 responses from a total of 326 local authority organisations. This was inclusive of all local authority types – metropolitan districts, non-metropolitan districts, unitary authorities and London boroughs – and was distributed across England. The scoping survey helped to identify the role of specialists and experts and the significance of a cohesive data visualisation strategy in the local authorities. The results illustrated three key pathways of production within local authority organisations and helped to illuminate the role of external actors and wider networks of production; both of these factors helped to inform the case study selection criteria.

The selection criteria identified four case study organisations, which helped to depict the types of local authorities which engage with data visualisation. Each of the four chosen cases was addressed throughout the following sections: Authority 1 (4.3), Authority 2 (4.4), Authority 3 (4.5) and Authority 4 (4.6). These sections utilised a mix of data from multiple sources: the survey results, the primary in-depth interviews and local authority reports, documents and local media articles. Each of the four cases was chosen to represent a particular type of organisation, whilst the scope in size and population of unitary authorities meant that two were required to get a full representation. The case study organisations were also presented in relation to their geography, dependent population and structure, and were contextualised by austerity, to give an indication of the services they deliver and their local needs. The second half of each case identified the organisation's particular practices regarding data visualisation; this was split between actors and pathways of production and mobilised the work of Kirk (2016) to identify the roles of data visualisation creation.

The final section of this chapter provided an account of the cultures and production processes of data visualisation. It noted that, although there are vast differences in the scope, size, services and economies of the organisations, there remain similarities in the modes of production. It highlighted the role of the three key forces (economic, structural and organisational) in driving the engagement of the organisations' operational practices of data visualisation. It links the attitudes towards data and the objective assumptions of data illustrated within the literature (section 2.2) to the working practices and attitudes revealed from the interviews. This section also provided an extension of the work of Kirk's (2016) eight roles of data visualisation production, to include the influence of key field leaders – a contribution which is discussed further in section 6.3.

5: A Post-Representational Approach

5.1 Introduction

The previous chapter has identified the local authority case study locations, which were explored through key themes which highlighted their similarities and differences. The case studies were contextualised by the effects of restrictive austerity spending measures and investigated through themes of geography, demography and engagement with data visualisation. This forms the foundation for the insights presented in this chapter, which thematically unpicks the operational application of data visualisations at each of the case study authorities. It does so through the application of a post-representational cartographic lens, answering the research questions:

- How and why do local authorities use data visualisation?
- How do visualisations ‘become’?
- How useful is post-representational cartography to understanding data visualisation?

A post-representational cartography has developed from the initial ideas of critical cartography – notably the work of Harley (1989), whose key text highlighted what could be learned from deconstructing the map. By challenging the view that maps are objective representations of the landscape, Harley highlighted the subjective nature of map making. He argued that maps reveal politics and are inscribed by the ideals of the dominant social groups they represent. Although significant in the development of critical cartography, Harley’s work has been critiqued as failing to move beyond the idea of maps as a representational practice. Crampton (2003) therefore suggests that we must consider the historic and geographical conditions which shape map creation and map use. Kitchin and Dodge (2007) further this by suggesting that it is beneficial to think of maps not ontologically, but ontogenetically. They should be considered as nothing more than ink on a page until they become a map through practice. As such, maps should be considered as being ‘constantly in a state of becoming’ (Kitchin and Dodge, 2007, 335).

Mappings do not appear and emerge in the same way for all individuals. Rather they unfold in context through a mix of processes and are affected by the knowledge, experience and skill of the individual to perform mappings and apply them in the world (Kitchin, 2012). This approach recasts cartography as a broad set of practices to think critically about the practices of cartography and not simply focus on the end product. In doing so, it creates a theoretical space which incorporates both those seeking applied

knowledge (asking technical questions) and those seeking to challenge the ideological assumptions of maps.

Contemporary data visualisation as a discipline – despite a vast increase in use and academic attention in recent years – lacks the rich theoretical history of cartography. However, comparisons can be made between previous cartographic theory and contemporary data visualisation (as discussed in section 2.2). Historically, cartographic advances have been focussed on asking self-referential, technical questions aimed at reflecting and improving upon how map representations are designed and communicated (such as scale, symbology, accuracy and readability), to develop rules and standards for how information is best displayed (Robinson, 1976). These approaches can also be traced into today's data visualisation discipline. Whilst developments in cartography have continued to push the theoretical understandings of the discipline, data visualisation remains within the boundaries of best display, as discussed by Participant 5A (a data visualisation researcher and academic).

Making new things was how to get things published, not really figuring out how those things fit together. The theory and filling in the gaps was not considered important or big enough a step and that's what is holding back the deeper thinking still. Someone has an idea and just goes off and does it – again, which can be a good thing, but if we don't have someone to go off and fill in the gaps and figure out how it all fits together, we don't have a cohesive field. (Participant 5A)

Considering data visualisations from a post-representational cartography perspective offers several benefits. They should be considered as ontogenetic, never fully formed, and they are brought into the world and made to do work through practices such as recognising, interpreting, translating and communicating, and are affected by the knowledge, experience and skill of the individual. Like cartography, data visualization focusses on how they work in the world, not just the end result, allowing for a theoretical space in which to consider a wide variety of chart types, actors, contexts, histories technologies and knowledges under one common framework (Kitchin, 2012).

This chapter questions whether it is possible to reconceptualise data visualisations as ceaselessly unfolding through processes and relational contexts. It does so by adopting the methodological pathway prescribed by Ingold (2010) who identifies post-representational cartography research as needing to follow the 'lines of becoming', tracing out how mappings unfold in the entangled conditions amongst the relations between actors of their creation, their use and the unfolding of everyday life and space. This is illustrated through an exploration of the constellation of actors and their interactions that shape the data visualisations unfolding within local authorities. These include knowledges (existing artefacts, manuals and guides), practices (aesthetic choices, conventions) immaterialities (equipment, software, paper, pens) and the organisations themselves (Kitchin, 2012b).

This research aims to present several contributions to academic discourse, which will be established throughout the forthcoming chapter. It aims to present an early attempt towards investigating the wide range of networks, actors, intermediaries and interactions that shape the unfolding, which includes knowledges (existing manuals and guides), practices (aesthetic choices, conventions), immaterialities (equipment, software) and the organisations themselves, as identified in the literature (Couldry and Powell, 2014; Ambrosia, 2015; Kennedy, 2017).

The research also presents a telling contribution towards addressing the lacuna in theory of data visualisation by applying the post-representational approach, which seeks to build on, rather than replace, the growing literature on data visualisation, and does not exclude the bodies of work from the adjoining disciplines. A post-representational approach recasts data visualisation as a broad set of practices, to think critically about the practices of visualisation and not simply to focus on the product. In doing so, it creates a theoretical space which incorporates both those seeking applied knowledge (asking technical questions) and those asking the theoretical questions. This research therefore presents a case for shifting the ontological position of data visualisations and considering them as processes, not as representations. Unpicking these conditions, as well as the aesthetic and technical elements of production, is key to providing a holistic interpretation of how data visualisations are actioned into being and made to do work in the world.

Further, this research makes a case for developing the work of Pickles (2004) and proposes that data visualisations be considered not as readerly texts (those that create readers for an already written text) but as writerly (those which require the reader to, in part, author meaning). Interpreting data visualisation in this way places recognition on the labour which is, in part, undertaken by the audience to gain insight, clarity and depth in interpretation.

This chapter seeks to untangle and make sense of the multiple, complex and competing processes which emerge in the unfolding practices of data visualisations. These are explored, unpicked and illustrated through five key themes, which have been adopted from Kitchin's (2012) work in post-representational cartography. Each is presented individually, in order to understand the complex unfolding properties of data visualisation, and their roles in both enabling and constraining the unfolding practices of the individual, as outlined below:

- Aesthetic
- Technical
- Social
- Political
- Embodied

Each of the frameworks is discussed and illustrated through the data gathered in the interviews. This chapter presents an account of not only the actors and their interactions throughout the data visualisation unfolding process, but a mixture of actors, their roles and interactions, their reflections on the technical challenges and the enabling, constraining influences of their organisations. Although it is the actors who are responsible for the creation and dissemination of information through visualisations, it is important to consider their interactions as a section of a much larger spectrum of influence. Unpicking these combined factors allows for a more holistic interpretation of the unfolding practices of data visualisations as they are (re)made within local authorities. Each of the themes forms the basis and structure for the following findings chapter. Although presented as five individual frameworks, this structure must be considered as a result of the limitations of thesis organisation and structure. In understanding data visualisations post-representationally, it is recognised that these processes do not exist in isolation. Rather they are playing out in competing, cohesive, multiple and simultaneous ways, exchanging and co-existing in various temporal patterns.

Section 5.2 discusses the first framework. It interprets the aesthetic unfolding processes as the data visualisations are brought into being. It discusses the work of Kennedy (2016), interpreting the role of conventions in shaping the design of data visualisations. It then unpicks the role of the aesthetic process in controlling the message of the visualisation and mediating the depth of interpretation (Kirk, 2016). Finally, it explores the aesthetic processes in the unfolding of data visualisation. It draws on the work of Kitchin (2012b) and highlights the role of familiarity and recognition as a visualisation, as well as the consequence of a user being unable to action the visualisation into being.

Section 5.3 illustrates the role of the technical processes in the unfolding of data visualisation. Identifying with the works of Del Casino and Hanna (2000), it interprets the differences between the

core set of technical skills in map reading and those of interpreting data visualisations. It then discusses the alternative technical processes which are more prominent to local authority data visualisation, notably format and technology. It then draws on the work of Warschauer (2004) to interpret the role of connectivity as an exclusionary force and the consequences of the digital divide. This section then draws upon the work of Gerlach (2012) in discussing the significance of user-volunteered time and the importance of cultivating playful, habitual and explorative processes. Finally, this section adopts and applies the work of Pickles (2004) to interpret data visualisation as moving from ‘readerly’ to ‘writerly’ texts, in which the reader is in part a co-author of the text. This produces a multiple and open series of readers, dependent on the user’s knowledge, interests and abilities.

Section 5.4 investigates the social processes in the unfolding practice of data visualisation. It draws attention to the various social contexts in which visualisations are mobilised operationally within the case studies. It draws on the work of Del Casino and Hanna (2000) to adopt and apply the notion of alternative narratives. In this sense, data visualisation unfolds through a combination of alternative voices which inscribe added meaning, depth and clarity to the visualisation, which in turn beckons it into being as a collaborative function. This section also considers the emotional labour as participants engage with data visualisation to communicate their performance within their departments. Using the work of Thorston (2018), it discusses the potential implications of this emotional toll on performance, which is then refolded into the visualisation.

Section 5.5 applies the work of Bohnert (2016) to investigate the political implications of visualising data. It highlights the importance of a critical consideration of data visualisations and challenges the objective assumptions of presenting data, drawing attention to the subjective choices of the designer in selecting whose truths to reveal. It also applies Kumar’s (2000) work on the democratisation of cartography, to inspect whether local authority data visualisation production is democratic.

Section 5.6 inspects the final framework and the embodied processes as adopted from Kitchin (2012). This section draws upon the feminist data visualisation work of D’Ignazio (2016). It begins by drawing on the work of Cairo (2016) and Posavec and Lupi (2016) to highlight the role of beauty and complexity in attracting user engagement, before interpreting local authority use of data visualisation as a means of creating an emotional bond with citizens.

5.2 Aesthetic processes

The previous section (5.1) reintroduced the research aims and the key literature which is being mobilised to provide the framework within which to explore what can be understood by applying a post-representational cartographic lens to data visualisation. This section explores the first key framework, identifying the key insights which can be gleaned as the aesthetic processes unfold. This section begins by defining what is meant by the aesthetic, the role of conventions and creativity.

This section begins by exploring the role of creativity and conventions in enabling the unfolding practice. It then unpicks the role of the aesthetic choices enabling and constraining an audience's ability to interpret information. This consequently enables the wider unfolding practices.

The aesthetic processes in cartography are the design decisions which create the appearance of the map. Critical cartography recognises the subjective choices of the map maker in deciding which symbols, sizes, scales, colours and information to prioritise. Following Kirk's (2016) work on data visualisation, the term 'aesthetic' is used here as a broad term for the design decisions and appearance of the visual, the selection of chart type and the intricate decisions beyond that until the moment of completion. This is inclusive of, but not limited to, colour, scale, size, layout and the choice of which data to include, which all contribute to how it looks, often adding flair and panache (Knaflitz, 2015). The look of the data visualisation is significant as it shapes the message and knowledge it produces (see section 2.2). The structures of each available chart play their own role in increasing the volume on certain aspects, whilst simultaneously muting the voices of others. They are also key to attracting investment and patience from the reader (Cairo, 2016). The vast, complex scope of the visual design means the aesthetic choices can define its audience. Its message and design carry notions of inclusion and exclusivity simultaneously as it begins to work in the world.

5.2.1 *The role of conventions*

This section seeks to highlight the processual account of the modes in which data visualisation emerges in design. It draws attention to the ways in which design decisions coax the visualisation into existence through iterative and experimental means, and to the literal and imaginative spaces which act as a canvas. It explores the role of scientific norms and conventions in shaping these decisions and exploring the opposing philosophies of data visualisation design within the case studies. Through considering which elements to present, the designer is able to construct insights.

Whilst there is a variability of chart selection, these decisions shaping the aesthetics of a visualisation do not exist through improvisation. Instead, they are the subject to norms and guidelines, presenting the

correct data in what is perceived to be its ‘correct form’. These are shaped from the prior experience, skills and training of the designer, often reflecting the image of a select group of influencers and trendsetters in the field of data (see section 4.6). Data is examined through the rules of visualisation best practice, which generates a number of predetermined standardised forms in this cross-referential process, in which the standardised shapes of the visualisation aesthetic design enable its unfolding practices.. As Participant 3A (in the role of data visualisation project manager) of Authority 3 states:

I’ve been trying to introduce to the team a consistent approach. So, if we have got this type of data, we can present it in this type of chart. What lends itself better? So just trying to educate our own staff so that we’re producing the right type of charts. (Participant 3A)

The aesthetic choices of the visualisation begin to emerge to the designer through a mix of referential processes, which iteratively build on the previous works, training, guidance and standardised forms by reapplying them to the current problem. These processes are underscored by personal philosophies:

I am from a computer science background, I’ll always try and have the most efficient use of space. (Participant 1D, data lead at the Yorkshire authority)

I like it to be bold and eye catching [...] think David McCandless [Infographic designer] (Participant 2C, performance lead at the southern authority)

Figure 5.1. Where does my money go? An example of the types of infographics described above, 2016 (Source: <https://datajournalismhandbook.net>).



The above quotes highlight the variety in philosophy. Due to the broad and interdisciplinary nature of data visualisation, there are multiple and competing philosophies. The first example highlights the role of previous experience and a disciplinary grounding in computer science, whilst the other resembles the role of a freelance trendsetter and popular leader in the contemporary field of data visualisation (see section 4.6).

Participant 3B, a designer in the northern authority, who primarily operates at a neighbouring authority, describes creating a visualisation:

We had done some work on a similar issue at my authority, so I just used the template I'd created on Tableau, I dropped new data in [...] it was very quick. (Participant 3B)

These conventions of data visualisation – the standardised forms, techniques and philosophies – choreograph the aesthetic design to a degree (Evergreen, 2016; Kirk, 2016; Kennedy, 2016). However, its message is not an inevitable consequence of these conventions. Instead, it is shaped by the intricacies – the variable attributes which emerge through more creative and reflexive processes, which are discussed in the following section.

5.2.2 Creative decisions

As the design of the visualisation continues to unfold, the conventions provide the framework through which the data – the lines and dots on the page – become organised and assembled into something which can be considered a data visualisation. However, the emergent practice does not cease. Rather the data visualisation continues to be reimaged, continuing to unfold through a mixture of creative processes. In this instance, the designer begins to embellish the artefact, altering and manipulating its form, tailoring its aesthetic appearance to meet the project's needs and their own aesthetic palate (Lupi and Posavec, 2016). This creates a tension between the wants of the designer and the needs of the user (as discussed in 5.4.1). This creates a temporary space in which the designer has more freedom to shift, shape and experiment with the visualisation.

That's the bit I enjoy because there's an element of creativity [...] Some people don't get it because they don't have an eye for graphics. (Participant 4C, designer at the Midlands authority)

The designer begins to shift the scale of the visualisation, zooming in and out, testing assorted colour schemes, applying annotations – each time beckoning a new visualisation to emerge, and then testing it against the needs of the project and its potential audience. The aesthetic appeal of the visualisation

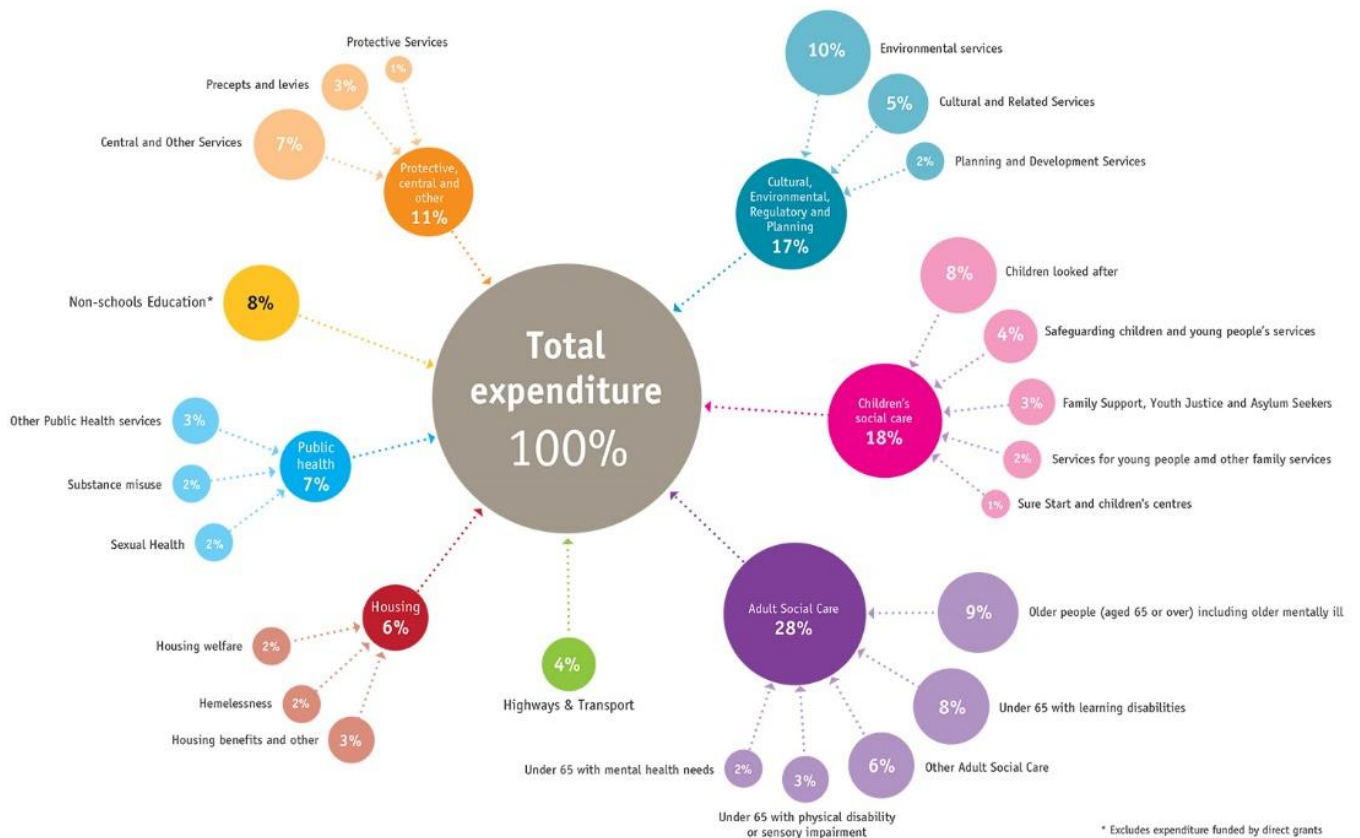
plays a key role in attracting the gaze of its user, as the look of the visualisation can increase participation and entice the widest possible audience (D'Ignazio, 2016; Posavec and Lupi, 2016).

I don't want art for art's sake [...] It's not always about creating something cool or exciting.
(Participant 1C, computer scientist and communicator at the Yorkshire authority)

Can I make it more engaging in lay terms? How do I make it more eye-catching? Can I convince them to invest more time in it? (Participant 1A, data lead at the Yorkshire authority)

Figure 5.2. London local government spending, 2014/2015. An example of the types of data visualisation cited above, 2016 (Source: <https://www.londoncouncils.gov.uk>).

Where the money is spent - London local government revenue expenditure 2014/15 (%)



As the designer seeks to answer these questions, they draw upon their own experiences as a reader of data visualisations, remembering the ways in which data visualisations have emerged to them, and drawing upon these as a point of reference and source of inspiration.

This illustrates the reactive and adaptive qualities of the emergent processes of data visualisations. Participant 4C, a designer at the Midlands authority, describes the way in which aesthetic qualities are beckoned into being in a less tangible way:

A lot of it is in my head, things I would like to see. I suppose it's a broad range of what's happening in the world [...] I look at a lot of news, how news is presented. (Participant 4C)

This highlights the imaginative processes through which visualisations are brought into being, drawing on a wide range of sources which are applied to the visualisation in playful and inventive ways. The designer can shape the visualisation within their imaginative space, creating a freer instinctual process. As the visualisation begins to unfold in these imaginative spaces, the successful ideas continue to unfold and are reinterpreted onto the page.

The creative freedom of the designer can, at first, seem limited to areas which have little impact on the key message of the visualisation. However, many banal decisions have a much larger cumulative effect on whether that information reaches its intended audience and whether it is remade.

5.2.3 Organisational conventions

The organisation setting leads to the production of conventions which constrain and control the production of the data visualisation. These working practices are reflected in its aesthetic appearance.

One key use of data visualisations in all the case studies was to display operational targets. The aesthetic appearance of the visual controls its message and the manner in which its unfolding practices become revealed and plays a key role in the way that information is transferred and understood. Participant 2A, a data scientist and communicator from Authority 2, describes their approach:

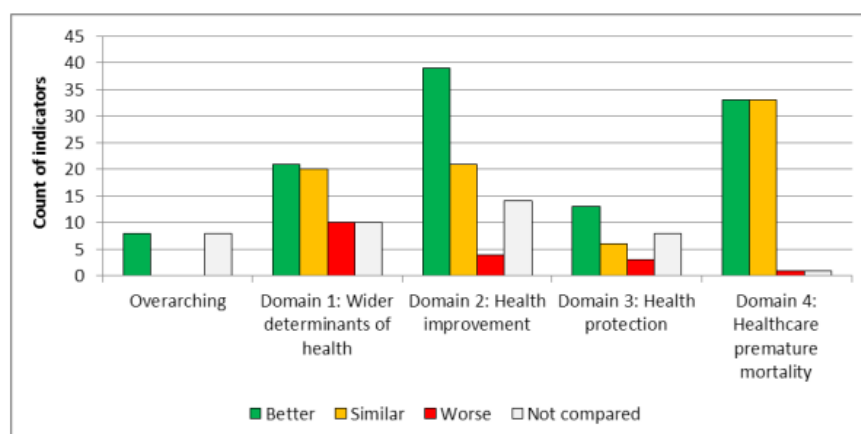
The chief exec, he wanted dashboards in red, amber and green, quarter by quarter. All printed off on one page of A4. It's really difficult for us to show what's happening, but it's what he wants. (Participant 2A)

Figure 5.3. Leicestershire Council Red, Amber, Green (RAG) ratings. An example of the type of RAG targets discussed above, 2018 (Source: <http://www.lsr-online.org>).

Table 1: Summary of RAG Ratings for Leicestershire August 2018

Domain	Better	Similar	Worse	Not compared	Total
Overarching	8			8	16
Domain 1: Wider determinants of health	21	20	10	10	61
Domain 2: Health improvement	39	21	4	14	78
Domain 3: Health protection	13	6	3	8	30
Domain 4: Healthcare premature mortality	33	33	1	1	68
Total	114	80	18	41	253

Figure 1: Count of Leicestershire PHOF RAG ratings, August 2018



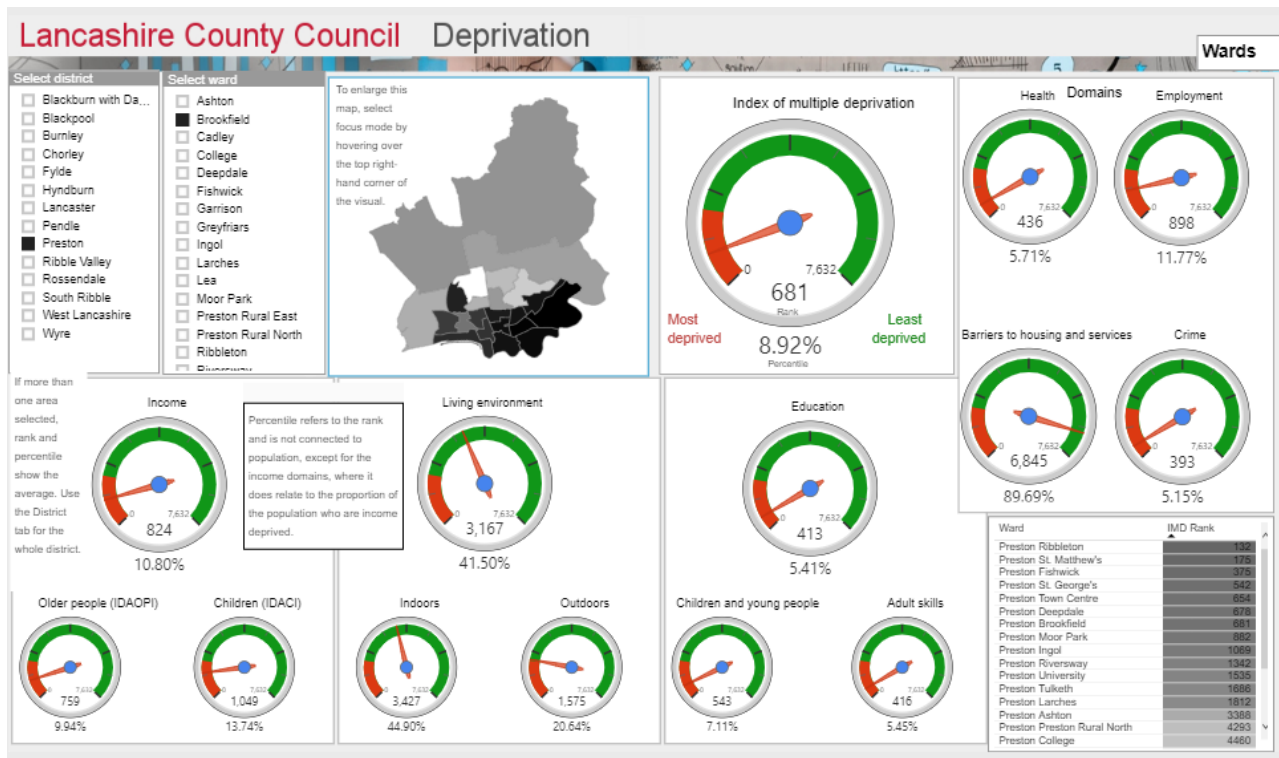
Each of the colours represents a level of attainment in relation to each target. In this instance, the look of the visualisation can be obsolete. The message of the visualisation is concerned only with the key target and whether it has been a success. In this example, the aesthetic design incorporated numerous indicators of service delivery. Each one is paired with its outcome from the previous quarter; the current is coloured green, amber or red, indicative of whether it is above expectations, meeting accepted expectations or below expectations. This limits the depth of the insight gained from the visualisation and the resulting message becomes constricted and devoid of context.

The Midlands authority offers a contrasting approach to the visualisation of targets. The visualisation above is more flexible and the approach more holistic, seeking to show the complex realities of authority performance. Participant 4A (project manager and data scientist) illustrated this point through the example of the public using council services:

Looking at this year on year, if you like, one of the comments that came from a cabinet member is can we compare Q1 to Q2, which is an interesting perspective, but what you find is that there are a number of factors which affect quarter-on-quarter growth. So it could be when Easter falls

in one year, you could be celebrating that it's gone up, but that could have been because of school holidays. (Participant 4A)

Figure 5.4. Lancashire County Council dashboard. A different approach to dashboards and targets, 2017 (Source: <https://www.lancashire.gov.uk>).



As we begin to consider each of these visualisations unfolding in their own contexts, we see that the organisational conventions have contrasting effects. The aesthetic design of the colour-coded targets limits the unfolding nature of the visualisation. Its message is definite; once the visualisation initially emerges, there is little room to explore and investigate the phenomena it depicts. It presents its message from a position of authority and truth, which on the surface rejects the unfolding processes and fails to acknowledge the competing processes which enable the continued unfolding. That does not mean that these processes are not occurring, but rather that they are not acted upon.

Unlike the previous example, at the Midlands authority, the aesthetic design of the visualisation incorporates far more information. In this example, the user is encouraged to navigate and explore different avenues of the visualisation – tracing the events and contexts of previous performance, meandering through a more holistic interpretation of factors and variables, before being able to conclude whether it was indeed successful.

What we're trying to do is move away from people reactively comparing one quarter to another, to understand overall why things are happening. We need to educate the office and members about why we display data. They'll say, can I have it in this way. I'll say, you can, but then you won't get this message. (Participant 4A, a project manager and data scientist in the performance team of Authority 4)

The 'look' of a visualisation is one of the key controlling factors in the emergent processes of visualisations, as the insights are contained within its aesthetic design. From the moment of contact between reader and object, the aesthetic qualities of the visualisation begin to emerge and to seduce and entice the reader into investing time in conceiving the message of the visualisation. The aesthetic nuances pose challenges to the reader which must be overcome if the message is to be revealed. The reader begins first by interpreting the shapes and patterns to make sense of the visualisation. Participant 1D (data scientist and communicator) from Authority 1 describes how he expects users initially to question the object.

Have they seen this before? What does it show? Can they make sense of it? (Participant 1D)

The reader seeks to understand the data by making sense of the lines, bars and shapes, through recognition of a mix of familiar patterns, trends and repeated techniques. They draw upon previous data visualisations they have seen, looking for aesthetic signposts and triggers to explain the phenomena. The authority staff recognise that, in order to maximise engagement of participants' interactions with data visualisations, they must reinforce staff confidence through consistent repetition and consistent design, which is discussed further in section 5.3.3.

That's why we try and have a consistent message, so they say, OK, we have this data for this chart, so they say, I've seen this before. (Participant 2B, a communicator from Authority 2)

In this example, the design conventions of the visualisation act as the gateway to the unfolding practices. Once the reader has formed an understanding of the aesthetics, they accept it as a data visualisation and begin to engage with it (discussed further in section 5.2.6).

In the following example, Participant 4C discusses this process in relation to presenting new types of visualisations to the public:

I understand a pie chart, I understand a bar chart [...] you can't just suddenly go, hey, have a starburst chart – it won't make sense. (Participant 4C, a designer from the Midlands authority)

And the issue continues when revealing information to operational staff within the organisations.

There's no point doing anything that complicated, they just won't look at it. Great ideas have been dropped because people can't understand the charts. (Participant 2A, a data scientist and communicator from Authority 2)

The above quote highlights the constraining factors of complexity and the limitations of unfamiliarity on the unfolding process (discussed further in section 5.2.6).

5.2.4 Aesthetics shape the message

The aesthetics are intrinsically tied to the message of the visual, providing the structural framework in which the meaning plays out. The bars, lines, segments and mappings of a visualisation signpost the work of the reader in unfolding the visualisation. They set the expectations for the user of how to approach the visualisation, offering a prompt to utilise their technical skills to compare phenomena, to understand change over time or to contrast change by location.

The transition from data set to visualisation relies upon the intuition and communication skills of the designer to interpret the significant insights and navigate these through the project's aims and the audience's abilities. The designer also adopts the role of gatekeeper to the message of the visualisation. Through interpreting the data in analysis, they begin to seek out the important insights, which become the basis for the aesthetic design. When considering the aesthetics of maps, it is recognised that processes to select which information is included run parallel to those which are discarded, privileging certain 'truths' while discarding others (Monmonier, 1996; Pickles, 2011; Rupert, 2014; Kennedy et al, 2016). The same can be said for data visualisations – despite giving the impression of revealing whole truths, they are subject to aesthetic restrictions due to space, form and comprehension time (see also section 5.3.7), which means that they only ever reveal partial narratives (Aiello, 2009). Participant 2C describes this process as having to 'slice and dice the information' to present the best possible solution to the problem at hand. In local authorities, this means that the designer begins to act as a gatekeeper to the knowledge. As Participant 4A, a project manager and data scientist from Authority 4, describes:

Ideally you define exactly what you want. They say they want to know everything, but what I think is, I will look at everything, I'll present what I think you want to know [...] There's a few amendments coming in from the meeting yesterday, I'll do some, but I won't do others because it will change the message. (Participant 4A)

The above quote highlights the responsibility of the aesthetic in framing the message of the visualisation. The aesthetic choices which are made begin to shape the knowledge which is revealed.

Although these practices are reliant on the subjectivities of the designer, they are rooted in the conventions and histories of statistical analysis (see section 2.2). Despite there being an acceptance of and trust in the role of experts in this process, the aesthetics still reveal tensions within the working environment. Reflecting on post-representational cartography, the aesthetics of the visualisation are identified as unfolding immediately to the user – in this case, their colleagues within the organisation. Several participants referred to the conflict between aesthetic expectations and the reality of the visualisation once it was revealed (Caquard, 2015). Discussing the issue, Participant 2A from Authority 2 recounted creating a data visualisation for a colleague based on their outlined criteria:

Once I showed them it, the immediate response was, ‘That’s not how I would have done it’ [...] I don’t think they had really looked at it, they wanted something more grand. (Participant 2A)

This quote gives an insight into the nature of the ways in which the aesthetics began to emerge. As the visualisation unfolded it did so comparatively against the aesthetic expectations of their colleagues within the organisation. This is complicated further in local authorities as the designer is not often not responsible for mobilising that information in the workplace. Therefore, there is often an added social and reputational consequence at stake. The aesthetics of the visualisation play a key role in how staff perceive their own work. This idea resurfaces again when discussing the impact of beauty and complexity in the embodied unfolding practices of data visualisation (I discuss this further in section 5.6.1).

The aesthetic design of the visualisation is responsible for tailoring its insights. The aesthetics can signpost key information and frame the nature of the discussion. Participant 4A, a project manager and data scientist from the Midlands authority, describes the situation of presenting visualisations to colleagues:

It’s interesting to see what questions they ask because when I get the data, I’ll look at it and probably ask different questions [...] If they’re asking different questions what I have prepared here isn’t what you need [...] I will go back and try again. (Participant 4A)

The previous quote highlights the limitations of visualising data as a ‘whole truth’ (see 5.5.1) and the role of a designer in unpicking the valuable data through subjective decision-making which creates knowledge (discussed further in 5.2.6).

5.2.5 Summary

This section explored the way in which the aesthetic processes are encountered as a data visualisation is beckoned into being. It draws attention to the way in which data visualisations emerge in design through a complex mix of co-constitutive factors, which are both representative of interdisciplinary backgrounds, and governed by scientific norms, momentary sources of inspiration, the availability of software and the ability of the audience. The role of aesthetic processes in shaping the message was discussed in section 5.2.4. To make sense of the visual and explore its message, the aesthetic processes unfurl, prompting further questions. These are enacted individually and constructed as a result of the collective social, technical, embodied and political processes (which are discussed further throughout this chapter; see 5.3, 5.4, 5.5, 5.6). The unfolding practice is confined and limited within the aesthetic framework of the visualisation. As the unfolding practices begin to expand beyond the aesthetics of the visualisation, the knowledge sought can exist outside of the lines and bars on show. As a tool to solve operational problems, the visualisation becomes unfit for purpose, and the aesthetics must be remade in order to adapt and reflect the ways in which it has unfolded to the individual. This prompts a cycle in which the aesthetics initiate and then limit the unfolding nature of data visualisations, the manner and knowledge which emerge through unfolding practices, then fold back into the aesthetic design. The visualisation is then recreated in order to best reflect its working practices, creating a cycle of interpretation and iteration through social interaction (discussed further in section 5.4.1). The role of aesthetic processes in shaping the message and therefore influencing the unfolding practice of data visualisations is important. As the aesthetics unfold to the individual through a mix of the assorted social (5.4), technical (5.3), political (5.5) and embodied (5.6) processes, they weave in their prior knowledge, which increases the understanding of the message, contextualising the results against their expectations, their experiences and using their skills to solve the task in hand. This means shifting from what Kirk (2016) describes as ‘what it shows’ to ‘what does it mean to me?’ (see section 2.3).

Within the field of data visualisation, there are conventions and norms which come from guides and best practice, and which are championed by leading actors within the field, who influence the design and aesthetics of presenting data (Evergreen, 2016; Kirk, 2017; Kennedy, 2017). Despite this, there is still a vast depth of possible chart types and modes of conveying information. Technological advances in recent years have simplified the production of the most complex data visualisations, whilst simultaneously increasing the number of available chart types (Knaflitz, 2015; Evergreen, 2016; Kirk, 2017). This is significant, as the last section drew upon the processes in which the initial point of contact created an aesthetic inspection of the data visualisation. The multiplicity of the ways in which data is presented means that users are confronted by increasingly complex and unfamiliar data visualisations. Kitchin (2012b) discussed how, in design, the aesthetics of a mapping must resemble a map so that they are recognised as maps and actioned into maps. In the case of data visualisation, the participants from

the local authorities described how, if a visualisation is to be enacted, it must reflect the user's own experiences, abilities and previous interactions with visualisations. Anything that appears aesthetically unrecognisable to the user is often neglected and never actioned into being by the user (see section 5.3.2). We must consider that if the user is unable to make sense of the visualisation from first contact, the object's function as a data visualisation is rejected. At this moment, its unfolding becomes suspended and it ceases to exist beyond a collection of lines, dots and bars on a page. As such, its information remains hidden within its aesthetic principles. In the local authority setting, the acceptance or rejection of the aesthetic components of the data visualisation have a direct impact upon the operational policies.

The nature of these visualisations encourages the unfolding processes. To encourage debate, discussion and further exploration (see section 5.4.2), the data visualisation becomes (re)made each time; a further variable is used to contextualise performance. Each layer of context beckons another data visualisation into being, in which the message changes and what is considered as a success is reinterpreted (discussed further in section 5.6.1).

5.3 Technical processes

The previous section in this chapter discussed the role of the aesthetic process in the unfolding practice of data visualisation. This section delves further into the research aim 'How do visualisations "become"?' by exploring and adopting the second element of the framework. This section focusses on the technical processes of unfolding, as identified in Kitchin's (2012) approach to post-representational cartography – that is, the technical skills required for the user to orientate themselves within their environment and the confines of the map, and then to utilise the map to negotiate a route. This is translated to data visualisation and the technical skills required to read varying chart types, as well as the skills required to negotiate a visualisation and interpret its message. This section will again mobilise case study data to highlight the technical processes which are both constraining and enabling the unfolding practices of data visualisation.

The following subsection looks at the technical nuances which translate the language of the visualisation into insight. The second subsection examines the much broader influence of the key skills of the participants – such as literacy, numeracy and language – as mediators of the unfolding practices. Following this, constraints of access, connectivity and time are discussed and explored as a means of exclusion and exclusivity, and their influence in the unfolding processes of data visualisation. The final subsection examines the role of the authority in finding solutions to critiques of access and connectivity,

and seeks to highlights the ways in which the case study authorities are beginning to improve the technical comprehension skills of the users.

This section identifies the technical processes which are enacted to bring data visualisations into being. The notion of technical processes is adopted from Kitchin's (2011) post-representational approach to cartography and gives reference to the technical map reading skills and the ability of the user to unpick the sign and symbols of maps, the skills required to place themselves within its orientation, and the actioning of it to solve relational problems. This notion of speaking the language of cartographic reason is adopted and applied to the local authorities' data visualisation in order to determine the role of the technical in their emergent practices.

5.3.1 The technical skills of map reading

In the unfolding practices of maps, Pickles (2012) describes technical map reading skills as being enacted by the map user in order to decipher and decode the language of maps, before actioning the object into a tool to get from A to B. The map reading skills enable participants to get their bearings, making correspondence between their surroundings and the lines and symbols of the map. By speaking the language of cartographic reasoning, users are able to recognise features from the landscape. By unpicking the signs and symbology of maps, they categorise key landmarks, primary roads and significant features, enabling them to understand their own orientation and leading them along a route; as they trace their finger along their journey, they again use the language of maps to anticipate upcoming key features. This is comparable to data visualisation – as the visualisation unfolds, the user must begin to inspect the visual symbology. This firstly exists through an interpretation of the chart type. Users process the overall shape of the visualisation, through a process of recognition and familiarity, almost instantaneously. Establishing the chart type realises expectations as to how to negotiate an inspection of the visual. Comparable to cartography, this can be considered as the users gaining orientation. Instead of looking for features in the landscape, the user seeks out key annotations, symbols and shapes. Each chart type incorporates its own particular visual prompts which guide the user as to how to proceed in analysing the object. As Participant 1A, a project manager from Authority 1, describes:

We want it to be consistent, I want them to see a chart and say, OK, I'm familiar with this, I know what to do next. OK, there's bars, let's see what each bar means. OK, there's lines, what is changing? (Participant 1A)

On becoming familiar with the visualisation, the user begins to explore more critically. Interpreting the details – the roads, contours and symbols of a map – the user begins to open a dialogue with the visualisation, speaking the language of visual reasoning, in which the user begins to trace along the

lines, comparing the bars and segments, to explore the phenomena being depicted. They are then able to tease out insights from the visualisation by examination of the visual prompts. This occurs through playful, habitual, reflexive processes. The ability to nurture an environment in which these processes of exploration and play can be cultivated is of great significance to the emergent practices of data visualisations. As Participant 5B, a data visualisation expert, states:

Some of it is almost muscle memory. People already know how to understand a pie chart, they see it and they know what to do. With some of the other charts, they look at them and they have to find their feet a little bit. Spend some time, say, OK, so what's happening here, what has changed, is this what I expected? (Participant 5B)

The above section highlights the importance of technical skills, familiarity and recognition in mediating a deeper interpretation of the visualisation; this is discussed further in section 5.3.6.

5.3.2 Improving technical skills

There are also authority-led practices intended to improve the technical skills of the audience, to mediate a more successful unfolding practice. This occurs through a cycle of production and feedback (see section 5.2.3). Incrementally increasing the skills of the audience and the complexity of the data visualisations allows the authorities to ensure that audience members understand and practice data visualisations. To do this, authorities are trying to familiarise participants with data visualisations, bringing a consistent approach to chart selection. This is intended to engrain the foundations of a technical skill set and understanding from which their ability to engage with data visualisations will develop. As Participant 3B, a designer and data scientist from Authority 3, states:

With certain graphs, the level of understanding would be very low, not because it's a bad visualisation, because just at the moment we're trying to move the people along in the conversation. We are testing the water to find out what might people understand. It's about getting people to look at graphics and numbers in a different way. I can only move it along at the speed at the feedback I'm given. (Participant 3B)

The authorities also engage with more formal consultation on issues which are in the public interest. As Participant 4C, a designer from Authority 4, states:

With things like adult social care, it will go out for consultation to the public. If I get back 'that was easy to understand' or 'that was easy to read', I can think, OK, so you got that concept. Then

I can look at the data, that simplest thing I did. I can make it more visually exciting. Because you understood that, so I can push the envelope a little further. (Participant 4C)

Figure 5.5. North Tyneside Council parks annual use. An example of simple public consultation with data visualisation, 2017 (Source: <https://my.northtyneside.gov.uk/>).

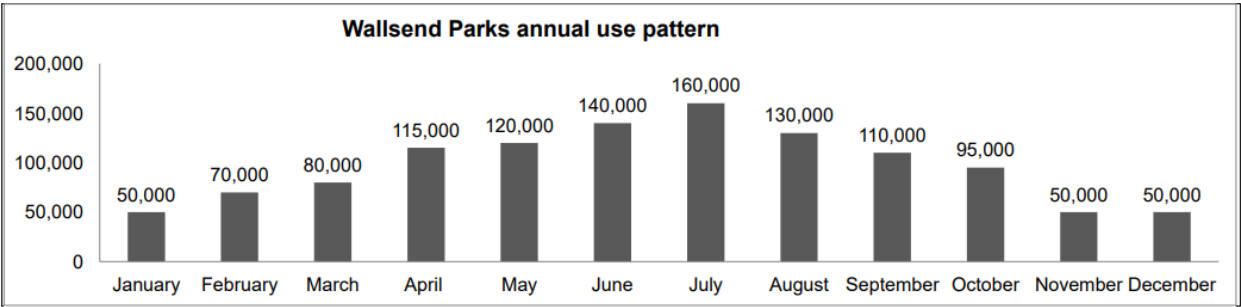
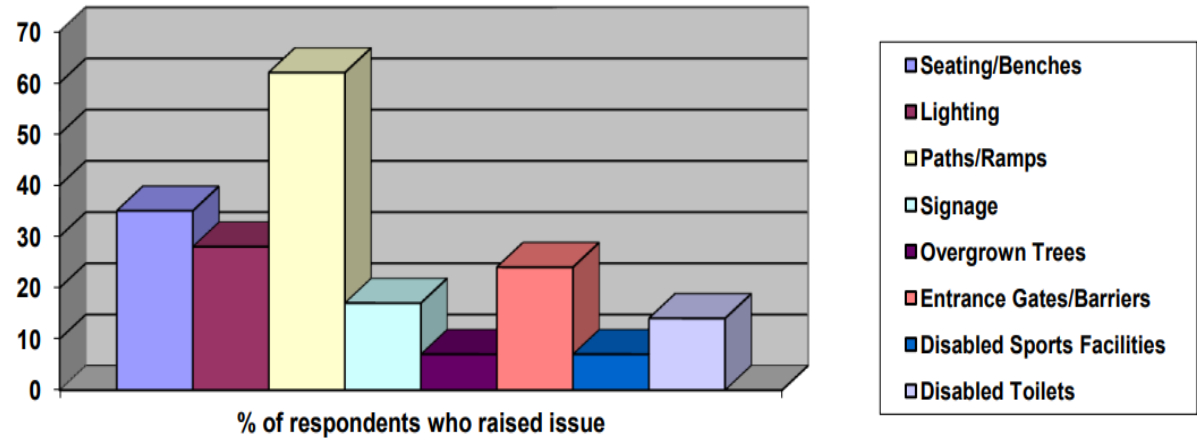


Figure 5.6. North Tyneside Council parks issues. A second example of a simple data visualisation used in public-facing documents, 2017 (Source: <https://my.northtyneside.gov.uk/>).



This consultation feedback process is integral to the unfolding practice and is discussed further in 5.3.6.

5.3.3 Understanding audience ability

Data visualisations are enacted as solutions to problems, either to communicate findings to an audience or as an analysis of complex data. In a local authority, the ability of the visualisation to communicate its message is hindered by both the technical implications of interpretation and the user’s ability to access the information. Operationally, data visualisations are mobilised as a tool to promote action, to

encourage a procedural change in working practices. As Participant 1A, a project manager from Authority 1, describes:

We have to question how many people can understand it. And how many people can then deliver an action following it. (Participant 1A)

In this example, the participant highlights the need for clarity and depth of insight, which illustrates Kirk's (2016) three stages of engagement. In this example, the user must travel through the *perceiving* and *interpretation* stages and into the field of *comprehension* (see section 2.3). In these stages, the user must first engage with the technical inspection of the visual, understanding what the key points mean before questioning the results against their own expectations of the subject. Finally, Kirk (2016) outlines the comprehension stage, in which the user becomes invested in the findings of the visualisation, asking 'what does this mean to me?' which then begins to prompt action (see section 2.3). As the visualisation emerges, the technical processes allow the data visualisation to unfold to the user. Without the technical skills to enter into what Kirk defines as the comprehension stage of engagement, the user is unlikely to respond to the visualisation with action. Therefore, it doesn't begin to emerge as an operational tool, as it doesn't promote any action or a change in approach from staff; it exists as a data visualisation, but its unfolding practices do not extend to their fullest capabilities and it fails to exist as an operational tool.

Although this PhD research does not investigate public experiences of data visualisation, participants did identify issues which influence their external engagement. When working with the public, the issues associated with technical processes become exacerbated further. When communicating externally, there is an acceptance that they must continue to aim to be as inclusive as possible to their audience. As Participant 3A, a project manager from Authority 3, describes:

It does mean that disseminating information to people, we're in a transitional time and probably are for the next five to ten years. We have to use several means of communicating, we can't just switch off. (Participant 3A)

When the authority is enacting data visualisations as a tool to prompt change or action from local citizens, it can't always rely on users having the ability or willingness to engage fully with the unfolding practices of data visualisation. In practice, this means becoming more proactive and targeted towards specific citizens. As Participant 4B, a computer scientist and communicator from Authority 4, states:

We have a tool to understand the characteristics of the people in an area. Say we have an issue with recycling, we know that people can't speak English, can't read English and are just generally

not receptive to it. So the best thing to do is knock on their door. So it's that intelligence, it's not just presenting the data, it's how can we improve issues and have an impact. (Participant 4B)

The technical skills and ability to speak the language of data visualisation differ greatly within the case study organisations. Due to recent changing working practices to a more data-focussed approach, staff have differing levels of access to technology, different volumes of data visualisation to engage with, varying backgrounds in terms of skills, and different levels of interest, which all contribute to their data visualisation literacy (as discussed in Chapter 4). Participant 4A, project manager and data scientist from Authority 4, described an exercise used in their authority to gauge the organisation's ability to interpret data visualisations on an individual basis:

We had an exercise in the past where we put all the charts up on the wall. People's interpretations of them varied dramatically. Whilst some of them were very technical and could easily understand patterns and trends, others just really struggled. (Participant 4A)

To further this, Participant 1A, an initiator and project manager from Authority 1, highlighted the mixed abilities of the audience is reflected in design. To address this, to maintain equality of access to the knowledge and to ensure that the technical abilities of all participants are considered, the chart type, complexity and content of the visualisation are often simplified to their most accessible form:

We have to produce one document with many audiences in mind, so we have to make sure everyone is on the same level and they all speak the same language. (Participant 1A)

Similar to speaking Pickles' (2012) language of cartographic reason, designers and practitioners from all cases referred to the technical process of interpretation as a language, and being able to speak and converse in that language is integral to the unfolding practice of data visualisation.

5.3.4 Alternative skills

The technical abilities of practicing visualisations are themselves mediated by much broader key skills. Before comprehension of the visualisation can take place, there are more fundamental issues which constrain the user's ability to unfold the object. The ability of the audience to engage with more general literacy and numeracy acts as a controlling mechanism to their engagement with the visual. Without this, unlocking the information in a visualisation becomes almost impossible. Whilst basic language skills such as literacy and numeracy could more generally be considered as a societal norm in the field of data visualisation, within Authority 4, this presents challenges when communicating with the public. As their local audience's ability, which has considerable scope and represents a broad range of ages and

mixed abilities. Participant 4B, a computer scientist and communicator from Authority 4, draws attention to these issues:

We have a major problem with literacy and numeracy amongst the general population. We are working with people over 65 and some of them can barely read or write. If they have poor literacy, they will also have poor literacy of the subject, it's a double whammy. (Participant 4B)

Format technology and connectivity

When engaging with a map, it is assumed that the user is already in possession of the object, and that when needed and necessary the participant begins to unfold the map in order to negotiate their route (Del Casino and Hanna, 2005). When engaging in the practice of data visualisation, the technical skills to interpret the visualisation do not begin at the moment of contact with the object. Rather they are constrained by the format. Before engaging with the visualisation online, the user must first negotiate access through an assemblage of digital devices, apps and programs (O'Reilly, 2004). As local authorities are increasingly being driven towards being paperless in their public communication, this factor is becoming increasingly significant. As Participant 1D, a data scientist and journalist from Authority 1, states:

It's online, we do some things that we print off. But we're going to more digital stuff because it costs us less. (Participant 1D)

Despite notions of greater transparency and equality of access by moving to online data hubs for publication, this digital shift can become exclusionary to large segments of the general population (Norris, 2001; Crampton, 2006; Farman, 2007). The required technical skills to interpret the visualisation are no longer the only determinant. The user must first be able to access a digital device, be connected to the Internet and then be able to speak the technical language sufficiently (Warschauer, 2004). They must negotiate a trail of software packages, search engines and browsers to locate the authority's website, before beginning to access or download the visualisation. Despite promoting the benefits of a greater dialogue between authority and public through online platforms, participants were also aware of the potential of designing customers out of the process.

Online gives more people access, but only a particular group of people. Even in the public sector, some of our colleagues, they didn't grow up using a laptop. We have councillors who won't even open an email. There is a massive divide in the digitally enabled. (Participant 1B, a data operative at Authority 1)

It's how you disseminate stuff. If it's only on a hand-held device or a tablet or a computer you're cutting out a lot of the customers, we're working with a lot of people over 65. (Participant 3A, performance team of Authority 4)

This illustrates an awareness amongst the staff of the ways in which the technical skills of unlocking the knowledge in a visualisation are embroiled within much wider debates of access, connectivity and being digitally enabled (Yu, 2002; Suiet et al, 2013), which ultimately enables and constrains their unfolding practices (Brotton, 2012; Kitchin, 2014).

5.3.5 Time

As maps are usually enacted to solve relational problems, such as how to get from A to B; they are usually actioned out of necessity. The map is enacted for as long as is needed in order to get to one's destination. In comparison, data visualisation often provides insight or communicates analysis into a particular issue. In order to maximise interpretation, users must be receptive and curious about the subject.

They want it to be immediate, but actually some of the more complex analysis doesn't present itself like that. You need to sit down and look at it. It takes time, I suppose it's our job to convince them to spend more time on the issues. (Participant 1A, data lead of Authority 1)

The above quote also suggests that it is a key part of the design processes to try and cultivate a visualisation and the context in which these readings take place. This aspect of time, although not a technical process, is a key driver to enabling the technical processes to emerge as the visualisation is brought into being. In a local authority setting, time appears to be a rare commodity. This is evidence of the lack of support for data visualisation as an operational tool. This reflects the culture of organisations towards data visualisations, which are at times considered to be something which should be an illustrative accompanying piece, to be ingested quickly, rather than an operational tool which takes time to explore and provides a depth of understanding of operations.

5.3.6 Summary

This section has explored the second key framework of Kitchin's (2012) post-representational cartography in relation to data visualisation. I have investigated the role of the technical process in enabling and constraining the unfolding practices of data visualisations.

The technical skills, familiarity and recognition are integral to developing a deeper understanding of the visualisation. What this means theoretically is that, as the visualisation begins to be explored, the

user begins to interpret the content of the visualisation and frame it within the intersection between their expectations, broader subject knowledge and personal outcomes. In doing so, the visualisation and their understanding of the world get (re)made in different ways (see section 2.4). The actions of exploring the visualisation continue to alter the user's knowledge of the subject, presenting new queries and challenges which are then actioned and folded back into the existing knowledge. Making sense of the visualisation is a correspondence between data visualisation and the world around us. In the operational setting, this means a discourse between data visualisation and the operational practices, whilst in public, this means establishing a connection between the data visualisation and its reflected discourse in relation to lived experiences (see also 5.6.2). Although understanding the need to design to the abilities of the audience, participants' notions of what constitutes a successful data visualisation contrast with the work of Kirk (2016) and Evergreen (2016), who highlight the importance of meeting the demands and needs of your audience (see section 2.3). The quote in section 5.3.2 (reiterated below) can be critiqued, as it challenges one of the fundamental assumptions of data visualisation: to provide clarity and understanding in communicating data for wider audiences.

With certain graphs, the level of understanding would be very low, not because it's a bad visualisation, because just at the moment we're trying to move the people along in the conversation. We are testing the water to find out what might people understand. It's about getting people to look at graphics and numbers in a different way. I can only move it along at the speed at the feedback I'm given. (Participant 3D, Authority 3)

In this quote, the designer aims to distance themselves from the responsibility of interpretation, diverting from the perspectives and guidelines of data visualisation handbooks (Kirk, 2016; Evergreen, 2016) and placing the responsibility of interpretation on the audience and their ability. This removes their own role in design from the potential constraints of complexity in the unfolding practice, instead insisting that the responsibility for interpretation lies with the user, and that overcomplexity – which leads to a lack of interpretation and an eventual exclusionary mechanism to knowledge – should not be considered as a determinant factor of a successful data visualisation. This is also opposed to the interpretation of cartographical thinking set out by Pickles (2004), where it is suggested that maps should be considered not as readerly texts (those which create readers for an already written text) but writerly ones (those which require the reader to, in part, author meaning). Interpreting data visualisation in this way places a recognition on the labour which is undertaken by the audience to gain insight, clarity and depth in interpretation. Understanding data visualisations through a post-representational lens is inclusive to interpreting them as writerly texts. In applying Pickles (2004), writerly texts provide a multiple and open series of readings. This is evidenced in section 5.4.2 through the scope of interpretation when presenting visualisations to broad audiences and the multiplicity of results this

produces. It is also evidenced through the role of adopted narrative voices to co-author the insight, prescribe meaning and expand the user's interpretation (5.4.3).

By understanding data visualisations processually and reflecting on how they emerge to the individual, the authority seeks to expand the potential and grow the audience's ability to engage in the practice of data visualisation. As the feedback loop continues, the complexity of the visualisations can increase, as can the required technical processes of engagement. This allows for incremental increases in complexity (see section 5.3.3), allowing the designer to engineer their own ability to produce complex visualisations through a mutual development, and increasing the audience's ability to engage in the unfolding practices of data visualisation (complexity and beauty are discussed further in section 5.6.1).

Even if a user has the required technical ability, the length of time spent investing in the visualisation, interpreting and absorbing its insight, can be voluntary (Gerlach, 2012). If these processes aren't allowed to fully unfurl, the visualisation is rendered partially folded. To maximise interpretation, users must be receptive and curious about the subject, or be convinced to spend more time engaging in the unfolding practices, either by drawing the gaze of the user through the beauty and complexity of the design, or by striking up an emotional response in the user (see section 5.6.1). The length of time it takes to fully interpret a visualisation can depend on the complexity of subject, the amount of information on show and the variables which are needed to provide clarity and insight. This is similar to Gerlach (2012) – the interpretation that maps are explored through playful and habitual processes. In the exploration and interpretation of data visualisations, these processes become increasingly significant. When beginning to mobilise a map, the user first begins by placing themselves within the orientation of the page to begin exploring; this brings a more personal interaction with the artefact. In the use of data visualisation, the user may only form a small part of a broad group of people – they and their environment are reflected in a statistical point. Therefore, the immediate interaction lacks a personal bond; instead it is the content of the visualisation, the subject area and the aesthetic choices which are responsible for attracting and retaining the gaze of the user.

5.4 Social processes

The previous section unpicked the role of the technical process in the unfolding of data visualisation. The following section centers on the third process, as identified by Kitchin (2012). It therefore examines the role of the emergent social process, which contributes to the unfolding nature of data visualisations. In a cartographical context, the social refers to the acquired knowledge and skills of the user, which is identified as their social history, as well as the social interactions and alternative narrative voices which

are present as the user actions a map into being. The same principles are applied to local authority data visualisations.

The first subsection examines the role of the social environment and confidence as factors in influencing how information is absorbed by data visualisation users within the case study organisations. It looks into the role of alternative narratives and data visualisation guides. The following subsection looks into the performative nature of data visualisations, utilising Dora (2009) illustrates the complex and performative ways in which maps emerge to the user within social situations. The third section borrows from Kitchin (2012) to explore the idea of social histories and as an enabler of the unfolding practice. These ideas are then explored from the perspective of the visualisation user, whose own social histories place different challenges on interpreting data visualisations. The concluding section examines the temporal nature of the unfolding practice as being of the moment and context dependent. Kitchin (2012b) notes that maps are not determinate or teleological, but should be considered as contingent, relational and embedded within the context of the moment (e.g. anxiety, frustration), and as an aspect of other tasks (e.g. attending a job interview, meeting friends, etc.). These elements are used to investigate local authority data visualisation as a social practice.

The idea of the social is presented from the perspective of local authorities, both as staff operating in a working environment, and the public who receive the information in their role as customers and consumers of information. Although a broad framing perspective, the social processes are presented in keeping with Kitchin's (2012) illustrative vignette, in which a map user recreates the map in the image of their own social context, local knowledge and lived experiences. This is applied to the field of data visualisations within local authorities and examines the roles of these social processes as the visual is (re)made (see section 2.3), highlighting the constraining pressure and restrictive nature of interpreting information collectively. The following section highlights four social themes which influence, enable and constrain the emergent properties of data visualisations.

5.4.1. Other narratives, guided tours and collaborative productions

Del Casino and Hanna (2006) discuss maps being absorbed by and unfolding within the social context in which they are picked up and used. They illustrate this point through the role of guided tours, which produce accompanying narratives, adding depth to the experiences of tourists as they negotiate the city of Fredericksburg. These narratives unravel simultaneously, and are entwined and folded into the tourist's interpretation of the map (Brown and Knopp, 2008; Swords and Jeffries, 2012). They can also be found in the emergent qualities of data visualisations as they become utilised in local authorities. In the case studies, data visualisations were seldom left in isolation and were often presented collectively with discussion. Therefore, the data visualisation expert in these scenarios begins to adopt the role of

‘tour guide’, offering an additional narrative to accompany the visualisation. They can provide context, clarity and technical assistance as the visualisation begins to unfold.

What we’ll do is we’ll sit down, me and one of the heads of department, and I’ll say, ‘Look, this is how we are doing.’ We’ll have a discussion [...] I’ll point out certain things and ask questions and they will ask me questions. (Participant 1A, data lead at Authority 1)

5.4.2 The complex performance

Dora (2009) describes the complex and performative ways in which maps emerge to the user within social situations. This idea of performance and social interaction is a key issue at local authorities, as information from the visualisation needs to be understood by large audiences with various levels of ability. Participant 3A from Authority 3 described the social, personal and work-related pressures which contextualise how visualisations unfold simultaneously to teams of staff. Although they recognise that visualisation will unfold differently to individuals, the working aspect of the authority means that the information in the visualisation needs to be understood collectively. This presents interesting social challenges.

It’s easy for me to understand, but when you explain it to people they nod. But do they get it? People need to feel comfortable enough to say, ‘I don’t understand that’, and not everybody does. You need to be in the environment to say, ‘Look, this is what I’m saying. Does it make sense to you?’ If it doesn’t, well, move on to presenting it differently. (Participant 3A, performance team, Authority 3)

Within the working environment, staff are under pressure to excel in their roles and are aware of their reputations as employees. Therefore, revealing information in large social situations becomes problematic. The pressure from peers of being singled out, of being seen as capable and intelligent, begins to suffocate the performance of the visualisation. In this example, Participant 3A described staff feeling the weight of peer pressure to be seen to understand the visualisation. Alternatively, once this dialogue begins, the social processes of the visualisation begin to create new understandings and experiences of the visualisation. As this happens, when the staff are unable to make sense of the visualisation, a dialogue begins.

If you didn’t understand, I’ll ask, ‘OK what did you understand, was it the chart itself? Which elements didn’t you get?’ I’ll use that moving forward [...] The most important person isn’t me because I like presenting information in a particular way, the most important person is the end user. (Participant 1C, computer scientist, Authority 1)

Again, this highlights the significance of the social processes as enablers of the unfolding nature of the data visualization (discussed further in 5.4.5).

5.4.3 Social histories

Kitchin (2012) describes how each map user brings the map into his or her own milieu. Here the maps are (re)made individually and formed through the intersection of the users' knowledge, skills and experiences. He illustrates this through unpicking a walker's use of maps. As users negotiate their route, those with a knowledge and history of the locale can articulate an analysis of the map data in a different way to someone unfamiliar – identifying patterns of towns, relationships between locations, social and economic histories and physical geography, amongst other factors (see section 2.3). Post-representational cartography allows us to understand that the knowledge, skills and social history of the individual are all woven into the emergent practices of data (Del Casino and Hanna, 2000 and 2002). Similarly, data visualisations can be considered as being brought into being differently, by people who will ask different questions of the data. Within local authorities, there is an acceptance of the individuality of the unfolding practice. This uniqueness in engagement is illustrated by Participant 4A, a data scientist from Authority 4:

Each person in the audience [local authority staff] will view the world in a different way. People will always ask different questions. Some will be more focussed on the past, some will be more current, and some will be on the future. Some will focus on a small issue, some will look at the big picture. (Participant 4A)

This highlights the process of interpretation of a data visualisation as practiced in operational practices within the authority. The situation describes presenting a data visualisation to a wide range of local authority staff members, from heads of departments to front-line operational staff.

In keeping with Kitchin's (2012) interpretation, one of the key determining features of the unfolding practice as identified by local authority participants is the individual's subject and work history. Through this, they have accumulated a wealth of insights, knowledge and anecdotal evidence in their role (discussed in more depth in section 2.3). These individual differences are beneficial for adding insight and depth, with the intention of providing a more holistic interpretation of wider issues. As Participant 3A, project manager of Authority 3, states:

I'm just looking at the data, I can't tell you what it says, what's happening in the numbers. But I don't have years of experience in children's education or in employment. They see things

differently to me, they will ask different questions, things I might not have thought of. So we need to work together. (Participant 3A)

This point is furthered by Participant 1C, a computer scientist from Authority 1:

We need to remember that, in spite of everything, these guys [the local authority operational staff] keep delivering. They have a wealth of knowledge and we need tap into that. (Participant 3B, Authority 3)

The above quote highlights the importance of the users' 'social histories', as outlined in relation to cartography (Kitchin, 2012); this is discussed further in section 5.4.5.

5.4.4 Of the moment

Understanding data visualisation as unfolding as an aspect of other tasks (Kitchin, 2012b) is also significant to authorities. Participants repeatedly referred to being in some way overworked. The effects of austerity and reduced staff have meant that staff continue to adopt multiple roles, often balancing several caseloads at one time. This is a point discussed by Participant 4E, data scientist of Authority 4:

I have three roles, that's because people keep disappearing, you get handed their work. I have two roles and then my day job. But because there is so few people now, you just have to buckle down, I can't always spend as long as I can on a project. (Participant 4E)

The effects of working conditions, stress, strain and pressure on the unfolding practice are discussed further in section 5.4.5.

In understanding the emergent practices of mapping, Kitchin (2012b) notes that they are not determinate or teleological, but should be considered as contingent, relational and embedded within the context of the moment (e.g. anxiety, frustration), and as an aspect of other tasks (e.g. attending a job interview, meeting friends, etc.). The role of the momentary context presents an interesting vantage point when unpicking the unfolding practices of data visualisations at local authorities. The unfolding of data visualisation within local authorities is embedded within the moment, but is contextualised within the broader meaning of the data. When considering performance data, participants are able to understand the difference between A and B. However, the moment is contextualised by whether the performance has been positive or negative. Has their work been successful or are there areas for improvement?

They're used to working in a particular way and have worked in that way for perhaps ten years. It's a difficult change to bring about. So when I sit there and tell them we need to change this, or can you work more like this, they begrudge it. They switch off, they're not interested. (Participant 3A, project manager, Authority 3)

The data visualisation is also contextualised through the broader issues facing local authorities and public-sector employees. As mentioned in the previous chapter (4, local authorities have seen significant changes to operations. Austerity has meant continued reductions in staff size and a shift towards technology and data as a means of doing more with less. Data visualisation is used as a mechanism for this, to enable a more targeted and streamlined use of staff. The context of the moment creates a tension as the visualisation emerges in practice – a point summarised by Participant 1C, a computer scientist from Authority 1:

They [the staff at Authority 1] feel uneasy and suspicious [...] I think it's perfectly OK to be suspicious about new technologies, and in my opinion not enough time is spent to contextualise that. Because you might come out wondering about your job, am I going to have to work differently? How will this affect me? (Participant 1C)

The data visualisers in this process appear from two contradictory perspectives. First, being able to assist the staff at the authority in continuing to deliver services in times of austerity. Second, by utilising their skills, they are able to achieve what would perhaps be unattainable given the lack of investment and economic resources. However, the continued success and drive towards efficiency is certainly changing the role of front-line staff and, as discussed in Chapter 4, all the local authority case studies have plans for further redundancies in place. When discussing the role of the designer in these feelings of unease, Participant 3B, a data scientist from Authority 3, considered their role as more autonomous in nature:

I go on what the data says. That's my job. I just show them what is happening. (Participant 3B)

This is in keeping with Kitchin's (2014) critiques of data as the bureaucratisation of decision-making and reinforces the critique that working from this position of neutrality enables actors to remove the emotional and human element from decision-making. Considering their work as being solely driven by the data allows them a protective shield from the often difficult challenges and consequences of operational decision-making.

5.4.5 Summary

The following section engages with the broad social processes outlined throughout the previous section and delves more deeply into how each of the social processes unfolds from a post-representational perspective.

Del Casino and Hanna (2000) discuss the role of alternative narratives (5.4.1). This is evident in local authority data visualisation. The participants discuss data visualisation as unfolding not only through the user's interpretation, but through the conversation, the actions of pointing, probing and tracing lines. The performance of a data visualisation begins to enable a more social, experiential unfolding, although in this example the visualisation individually unfolds to each recipient. The 'tour guide' (in this case, the data visualisation designer; see Chapter 4) has added depth, clarity and understanding to the unfolding practice of the other user (Brown and Knopp, 2008). Therefore, to this individual, the data visualisation emerges as a collaborative function. With each social interaction and each question answered, this reframes the understanding and interpretation of the visualisation.

The complex performance was discussed in section 5.4.2. In relation to data visualisation, the social environment restricts the data visualization readers ability to feel confident enough to engage in dialogue with the visualisation. Because of this, the social context in which the visualisation is revealed becomes a key factor in limiting how much information can be gleaned from the visualisation. By removing the performative dialogue with the visualisation, it removes the possibility of adding clarity, interpretation and explanation (Peluso, 2005). Without this, to these individuals, the data visualisation emerges as warped, limited and constrained. As such, the social context constrains the unfolding processes.

Through these processes, the social interactions begin to create new understandings of the visualisation. The unfolding practices from all individuals are fed back into the visualisation, making it more legible. In these moments, the users are considered as both producers and consumers of the visualisation. In local authorities, this presents opportunities for operational changes. Designers learn from these social unfolding processes. Future visualisations are adapted through reinterpretation of the unfolding practices. As a result, visualisations become more inclusive of the abilities of the staff and their experiential interactions with the visualisations (see also 5.3.2).

The previous subsections recognise and illustrate the operational importance of interpreting the individuality of the unfolding practices of cartography (see section 2.3). The participants, without referring to a post-representational approach, recognise that the visualisation is dependent upon the moment, the temporality and the context in which it is revealed. There is also a drive towards harvesting the unfolding practices and feeding them back into the operational processes to expand insight into the

issues. In this sense, the social histories of the locale are replaced by subject expertise and experience in the working role in relation to the visual.

Data is filtered through the user's interpretation of previous work, their expectations of the data and its potential implications for the operational practices of the individual. The positive or negative tone which is articulated has different implications for the level of participant engagement. Being presented with negative feedback presents an additional emotional labour to the working practice (Jay, 1996), leading to the user feeling disheartened and undervalued. The consequences of this emotional toll can often manifest themselves through workers reaching 'burnout' (Brotheridge, 2002). As Thorston (2018) notes, the emotional toll of negative feedback can manifest itself through reduced levels of performance, negative work attitudes and a low sense of efficiency. In this example, it restricts the user's willingness to engage with the visualisation. But it also begins to feed back into operational performances, which can lead to continued and repeating negative responses to the unfolding practices of data visualisation (discussed further in section 2.3).

This section also drew attention to the social anxieties and overarching pressures which contextualise the unfolding practices of data visualisations within local authorities, in keeping with Kitchin's (2012b) illustration of the anxieties which occur when negotiating a new city, map in hand. Viewing data visualisations in this way allows us to interpret and highlight the frustrations, pressures and worries which emerge through their unfolding. These feelings can shift and alter, but are dependent upon the message of the visualisation and its relationship to the working practices of each individual (see section 2.3). The stress, strain and pressure attributed to working conditions are also influential. The time frame attributed to each project is minimal, with participants often juggling numerous projects, meetings and deadlines, which has a direct consequence on the unfolding practices of the visualisation. This leads to participation fatigue amongst users. The emotional burden and pressures attributed to the constant push and pull of caseloads mean there is no flexibility in the time invested in visualisations. Their engagement remains fleeting and, as such, constrains, contorts and limits the insight of the visualisation as it begins to unfold.

5.5 Political processes

Having explored the social processes of the unfolding process of data visualisation in the previous section, the following section applies the fourth key process of post-representational cartography (Kitchin, 2012). Therefore, this section will unpick the political processes in the emergent practice of data visualisation. The political processes in cartography refer to the political nature of maps, the ways in which they are inscribed with the values, ideals and contexts that have created them (Harley, 1988;

Pickles, 2004; Monmonier, 1996). It also explores the political nature of access to information and whose knowledge can be considered as authentic. Again, the same interpretations will be mobilised in relation to local authority data visualisations.

The political, in this sense, refers to the forces of influence that underpin how knowledge is created and disseminated within and from local authorities, the influence and control with which truths are revealed and who can access them. Boehnert (2016) identifies the practice of data visualisation as being political in nature, reflecting the power relations, special interests and ideologies of the creator. By presenting truth claims, the data visualisation privileges certain perspectives (Pickles, 2011). As such, neither the data nor the data visualisation can be considered politically neutral (Gitelman and Jackson, 2013). Within local authorities, there are varying political processes which influence the way in which visualisations unfold. In understanding this constellation of factors, Boehnert's (2016) interpretation is expanded (discussed further in section 2.3), raising the possibility that not only are visualisations being inscribed in the subjectivities, unconscious subjectivities and interests of the creator, but that the organisation itself is acting as the main publishing vessel. This means all data visualisations can be considered equally anonymised and credited to the authority, reflecting at once the subjective position of the creator and the ideologies and interests of the authority.

5.5.1 Excluding, transforming and reshaping information

The operational use of data and its visualised form is influenced by the role of politics within the organisation. The following sub-section draws attention to the political influences which are felt in the production of data visualization.

Participant 2A, data scientist of Authority 2, describes the influence of politics on the operational use of data visualisation:

Fundamentally, as I said, no matter how good or bad the data is, we will still be influenced by local politicians and the culture of the organisation. Because all organisations are, it's just at a local authority setting you have an additional hindrance and help of local councillors. (Participant 2A)

This draws attention to the way in which data visualisations operate under the banner of the authority. There is an attached accountability of the content, due to the political nature of the organisations and a pressure to reflect the image the organisation perpetuates. The release of data visualisations and data gives the opportunity for the public, opposing political parties and the media to scrutinise the work of

the authorities. Therefore, there is a responsibility for visualisations to be in keeping with the ideals of the authority and to protect its reputation.

There is also a manipulation of the aesthetics of the visualisation to create a message which reflects more positively on the organisation (see section 5.2.3). Participant 4E, data scientist from Authority 4, describes the situation of creating a quarterly dashboard to be presented to the public in a newsletter. It displayed indicators of performance – in this case, universal credit (UC) claimants. The aesthetics of the visualisation created a conflict between designer and political members of the authority.

The issue was it looks like our claimant rate is increasing, when nationally it's going down. When actually its people transferring onto the new benefit system from the previously functioning JSA. So we had a number of discussions around: do we present data by quarter, do we present it cumulatively, or annually? Well, ultimately it depends on what message we want to put across. The members, they'll be like, oh, this just looks as if it's increasing, we can't use that. (Participant 4E, data scientist, Authority 4)

Similarly, in Authority 3, Participant 3B (communicator and project manager) describes how they continue to use statistics related to JSA claimants, as it presents a favourable interpretation of how the area is performing, despite hinting that benefit claimants have simply begun switching to other forms of benefits.

At the moment we're in one of the better performing areas for JSA. It's strange because it's gone down. In the last year it's gone below 25%. Whether or not that is because they have switched to another benefit is another story. (Participant 3B)

These aesthetic choices are inherently political; they are by no means an accidental design decision. Although the visualisation is still bound by data, the aesthetic choices were intentionally set in order for the visualisation to create favourable results. By expanding the time frame or scale, or by persisting with dated variables, it presents a position of success within the national league tables. This controls the way in which the visualisation unfolds to the individual (see section 5.2.3). This is illustrative of the transformative qualities which are applied to data visualisations. As they begin to transfer from internal documents to those in the public domain, there is a refining and filtering process which is applied. Again, this is a functional process by the authority in order to maintain a controlling stake in the communication between both parties (Ambrosio, 2015; Swords and Liu, 2015).

The political nature of the authorities means controlling the narrative of the visualisation in order to protect the image of the authority. As Participant 4A, data scientist of Authority 4, highlights:

This is basically how the council's performing in terms of its budget. It's not something we report externally because then we could perhaps be accused of using our department as a bit of a cash cow. (Participant 4A)

In this example, the visualisation being discussed showed the budget and, more importantly, the increase in revenue from the performance team as a business. The implication here is that the public's perception of the department would be negative, which could detract from the messages the authority wants to reinforce. In this example, the operational result was that the use of that particular visualisation was limited to within the performance team and the councillors. Only employees working directly on the projects had access, whilst those in the public domain were excluded entirely. In this case, the role of the authority and its political nature began to control the wider narrative of communication with the public (creating a positive emotional bond with citizens is discussed further in 5.6.2). As visualisations are integral to this, they are implicated in controlling or excluding knowledge from certain stakeholders, both internally and in public-facing exercises.

5.5.2 Organisational hierarchical pressure

There are also political processes in play within the hierarchical and internal structures of the organisation. Participants involved in data visualisations within various performance teams felt pressure from superiors to promote positive results. Participant 4D, a data scientist from the Midlands authority, drew attention to this:

Because fundamentally they work in the performance team, the performance team need to show good outcomes. (Participant 4D)

That's where the politics and danger comes in. So from that point of view we've got to be really sharp, even if it doesn't tell us what we want. The point is the data, it can be seen as objective, but it's equally not. (Participant 4D)

In the above quote, the participant references the perceived objectivity of data visualisation. There is a power in the scientific guise when presenting data visually. As D'Ignazio (2015) states, even though, rationally, users know data visualisations do not represent the whole world, they have an ability to appear aesthetically scientific and present a neutral and expert point of view, as if from nowhere (see section 2.2). From this position, the visualisation is able to present its truths with an assumed authority, despite its numerous manipulations (Latour, 2011).

Although there are political processes at play during the unfolding practices of data visualisations in this setting, it is something which staff are aware of. Recognising the tensions that exist whilst working with data visualisations in local authorities, Participant 4D, a data scientist from the Midlands authority, states:

We all know it doesn't matter how good or bad the data is, politicians will abuse, use and misuse data. In the best of ways and the worst of ways, they don't speak the language of statistics.
(Participant 4D)

This draws attention to the different appreciations of data, and the cultural implications and ethical boundaries which exist when creating data visualisations. This point is also reinforced by Participant 2A, a data scientist from Authority 2:

It's quite scary here, because it's different politics, we're dealing with local politicians and also we're dealing with different hierarchies, different structures, different appreciations and understandings of what data is. (Participant 2A)

The above quote highlights the political pressures and competing, conflicting contexts which are embedded within a data visualisation. These are discussed further in section 5.5.3.

5.5.3 Summary

The previous section has unpicked the political processes in the production and practice of data visualisation within the local authority case studies. The following section utilises that evidence to interpret data visualization as unfolding from a post-representational perspective. It began by discussing the role of political processes in reshaping and transforming the visualisation – as the aesthetic of the visualisation unfolds, it can suggest a message that can be deemed unusable. At this moment the visualisation must be reimagined. By altering the scale or the frequency of the table, the designer begins to create different interpretations of the phenomena. Each incremental change begins to change the overall impression of the visualisation (Gitelman and Jackson, 2013; Hill et al, 2017).

D'Ignazio (2015) refers to data visualisation as being political in nature, as it reveals certain phenomena, while concealing more complicated realities (see also 2.3). This can be seen from the above examples – in the cases of visualising both the JSA and the UC claimants, both participants discussed creating a simplified message. In doing so, they became complicit in obscuring the complexity of the situation, in favour of a more compelling truth rooted in the interests of the organisation (Swords and Liu, 2015; Hill et al, 2017). This notion of visualisation concealing realities can be extended further within local

authorities. As Boehnert (2016) notes, in order to understand data visualisation critically, we must recognise which stories are being told and anticipate which are not being told. This is highlighted in the previous passage, as even with a controlling stake in the narrative of the visualisation, there are certain truths which are completely excluded from the public gaze (see also 5.2.2).

This section discussed the organisational and hierarchical pressure facing data visualisation production. Data visualisations are created in a process involving multiple decisions: which data to collect, which to illustrate, how to illustrate it and where to publish. These are all decisions that reflect assumptions, unstated, unacknowledged ideological perspectives and subjective judgements (Boehnert, 2016). These iterative design decisions are actively playing out in the production of data visualisation within local authorities. The previous section (5.2 and 5.3) outlines the ways in which the message of the visualisation can be transformed as the designer engages in a dialogue with these debates (Hill et al, 2017; Kennedy, 2017). To further complicate this, within the local authorities, the decisions which are incrementally implemented throughout the design process are split amongst a vast ecology of actors from varying rungs within the hierarchical ladder, all with their own specific aims, agendas and ideals. Because of this, the visualisation is embedded within a tangled web multiple competing and conflicting contexts, all being played out iteratively and interchangeably through the unfolding practice.

This highlights the way in which the influence of the political nature of the organisation continues to be felt within the content of the visualisation. It begins to embody and reproduce the context in which it was made. This becomes apparent as we untangle the production process through the application of a post-representational approach (discussed further in section 2.3). To the public, or those unfamiliar with the production process, these influences remain hidden and out of sight (Aiello, 2006; Rupert, 2014). Again, in this example, the visualisation continues to be (re)made on an individual basis. While to the designer, the visualisation emerges as successful if it portrays accuracy, clarity and readability, to the other staff members, a successful visualisation is something which shows progress and attainment of targets throughout the department. Notably, design staff also reference the lack of critical understanding of data and subsequently data visualisation from other members of the authority. This is in keeping with what Kumar (2000) terms the democratisation of cartography. The Internet has revolutionised how maps are made and communicated. The medium has become more accessible in terms of consumption, through an increase in available technologies and mediating software such as Google Maps (Crampton, 2006; Farman, 2010), and individuals are now becoming empowered with the electronic tools to analyse and visualise spatial data (Jordan, 2011). The increasing accessibility of cartography, although still limited, has helped to instigate new modes of participatory and open-source mapping. Despite this, it has been critiqued that new, inclusive forms of mapping have had a diluting effect on the principles, theoretical grounding and ethical implications which exist in the creation of spatial information (Crampton, 2004), which is discussed further in section 2.4.

The critiques of the democratisation of cartography are highlighted in local authorities' operational approaches to data visualisation. The primary designers and specialists are considered experts, but as the operational use of data visualisation becomes further embedded, the speed of production begins to outweigh the possible workload of the designer. This becomes problematic as design decisions are given to those who are less acquainted with the nuances and applied theoretical perspectives of data, its working practices and ethics (Dodge and Kitchin, 2013). The working hierarchy also means that there is a shared responsibility of production, in which the designer operates in a role as data expert, but is not the sole decision-maker with regards to output. What this means to the visualisation is that its message becomes further entrenched in the subjectivity and politics of the organisation and the ideals of its hierarchy.

This can also be considered from a cultural perspective in relation to data visualisation. Because of this democratisation, staff are less aware of the potential power of revealing knowledge, and so they are less considerate of the ethics of data and research. This leads to a misuse of the visual, which is considered to be an illustrative piece to accompany a predetermined message, rather than as a tool used to solve analytical or communicational problems in data.

5.6 Embodied processes

The following section examines the nature of embodied processes in the unfolding practices of data visualisations. Although referenced by Kitchin (2012) as one of the key identifiers in the unfolding of maps, there is otherwise little explanation of the defining characteristics of an embodied mapping practice. As such, this section adopts D'Ignazio's (2016) work on feminist data visualisations as the grounding from which to untangle the embodied practices of data visualisations, identified as experiences that derive from emotion and sensation (see section 2.3).

This presents us with two key perspectives from which to interpret embodied local authority data visualisation. The first section explores D'Ignazio's (2016) notion that data visualisation engages and impresses with beauty and complexity. This is examined through the local authority case studies, examining the corporate role of data visualisations, the desires of designers and notions of attraction, beauty and complexity when engaging with broad public audiences. The following section examines the second key perspective and considers whether data visualisations designers can leverage affect to create an emotional bond with the story or user (D'Ignazio, 2016). It explores how local authorities

harness the language of emotion within data visualisations and their accompanying texts, through notions of togetherness, local pride and a caring community.

5.6.1 Beauty and complexity

In interpreting the embodied processes, D'Ignazio (2016) suggests that we must begin to consider the ways in which complexity and beauty are mobilised to engage, impress and attract users (see also 5.3.2). Within Authority 2, this idea of beauty and complexity is considered the missing ingredient for maximising the potential of their data visualisation capabilities to a corporate audience. As Participant 2A, data scientist and communicator from Authority 2, states:

I see our department as making snazzy, bespoke visuals to hammer home the key operational and financial insights. So far, there is already some very good data analysis happening, mostly in Excel. But it's the flair that's missing. We need that to communicate findings to the wider corporate audience. (Participant 2A)

In this example, the participant recognizes the complexity and impressive nature of data visualisations as a key indicator of their value. In keeping with D'Ignazio (2016), the participant hopes to attract customers, develop partnerships and explore business opportunities in the corporate sector. Despite recognition that there is 'good data analysis happening', the participant also acknowledges that, in order to truly impress in the corporate sector, they must adopt a different epistemological perspective. Moving from the more computer science-orientated approaches, which are driven towards effective, efficient design, to a more visually enticing design, in which importance is placed on complexity, flair and aesthetic attraction (which is seen through the debates of art and science in 2.3). This is a reflection not only on the perspective of the individual participant, but the broader culture of corporate data visualisation, as projected in the role of trendsetters and field leaders in Chapter 4 (see section 4.6).

There is a clear distinction between data visualisations targeted towards a public and a corporate audience. When working with the public, the designers were driven by the ability of the audience to understand and interpret the visualisation. This, in effect, constrains the complexity and artistic elements, instead focussing on reducing visualisations to their simplest forms. As Participant 3B, a designer from Authority 3, states:

The software can be misleading. Once we got the license, the expectation was that we will have these complex, beautiful visualisations. People were a little bit disappointed, but we have to be more pragmatic than that. (Participant 3B)

Despite recognising the importance of simplicity, the designers themselves illustrated that they placed a clear personal value on more artistic, creative and challenging data visualisations. But they also recognised that their requirements are secondary to the purpose of the visualisation, which is to cultivate understanding. This is a point highlighted by Participant 3C, a data scientist and communicator from Authority 3, who states:

I love doing it. But it didn't satisfy my creative side enough, it didn't test my brain enough. I want to make them more visually exciting, even if it's just for me. But now we can't do that.
(Participant 3C)

5.6.2 Creating an emotional bond

In discussing the embodied process of data visualisation, D'Ignazio (2016) identifies unpicking the way they leverage affect, in order to create an emotional bond with the user, as a crucial aspect of an embodied data visualisation. In local authorities, this practice is prevalent and emotion is weaved throughout their data visualisation practice to create empathy and to cultivate a collective identity (Cawthawn, 2007).

Data visualisations as artefacts should not be considered to emerge in isolation; they are co-constructed by a myriad of other voices. When publishing public-facing visualisations, they are often located in reports and removed from the possibility of having a dialogue with the creator (see section 5.4.1). As such, the accompanying texts play the role of the narrator, guiding the user through the content and signposting key points. Within case studies, the accompanying texts often speak the language of emotion, drawing upon themes of togetherness, community and empathy between authority and population. An example of this can be seen through annual budget reports. Contextualised by the enforced austerity spending measures, all the case studies showed reductions in spending across services (as highlighted in Chapter 4). The accompanying texts and press releases at all the case studies attempted to connect with users on an emotional level and to humanise the proposed budget decisions. There were frequent references to the difficulty of addressing further reductions to service delivery in their most recent budget proposals:

tough choices (Authority 1)

most difficult budget in history (Authority 4)

no easy way to find solution (Authority 2)

no alternatives (Authority 3)

The adopted language attempts to harness emotion and to humanise the decisions to reduce services, creating a shared understanding between the authority and the local population, and to provoke an empathetic unfolding of the visualisation. As Participant 1B, a computer scientist from Authority 1, states:

We always try to highlight the good work we do. To show that we really are trying our best to meet the needs but there is only so much we can do. We need them to understand that we are in this together. (Participant 1B)

In speaking in an almost apologetic tone, the councillors quote attempts to bring a humanistic voice to reductions in service delivery. There is a resignation in the choice of words which aims to illustrate the authority as a powerless entity of central government decisions. It highlights how, despite reductions in spending, the organisation still cares for the community, and prompts public sympathy for the difficult position of the authority. Although, to fully understand whether these mechanisms are successful, this research would have to further investigate the unfolding practices of the public, external to the local authority.

In Authority 4, there is an ongoing issue with fly-tipping. In the year 2016/2017, the number of incidents grew to approximately 8,000, with a total to the authority of almost £600,000. Attempts to prosecute offenders were unsuccessful: only 29 people were fined a total of £8,933. Because of this, the authority sought to take an alternative approach to deterring and preventing further incidents. As Participant 4A, a project manager and data scientist from Authority 4, states:

One issue is people don't think it's a big problem. So we wanted to use the data to show them. To shock them. To make them see that actually this is a big deal and because we are spending so much it means we can't do the things we want to. We needed to get them on board, because what you find is, as soon as people see one incident, they join in. So, we need to get them to care [about their local environment]. (Participant 4A)

The leaflet consisted of two simple bar charts, one showing the increase in the number of incidents per year, alongside a replica showing the increasing cost per year. It was distributed to addresses in areas identified as hotspots, which were compiled as a visualisation of the mapped reported historical incidents. Unlike the previous example, the data visualisation itself was the tool with which to provoke an emotional response. As Participant 4D, a communicator from Authority 4, notes:

I don't think we needed text, the numbers speak for themselves. We want people to be outraged and to report the incidents. We want them to think not only is it making places rundown, but we could be spending that money on people that need it. That's why we want them to start reporting it. There is a direct phone number, a web page and we're making an app. (Participant 4D)

Illustrating the scale and cost of the problem was meant to instigate feelings of shock, dismay and disgust amongst the residents, in turn cultivating an emotional bond with the residents and seeking to 'other' the perpetrators by publicly shaming their actions to their local community.

We want them to feel like, OK, we need to change. Let's make this a nice place to live, let's work together and try to restore some local pride. (Participant 4C, a designer from Authority 4)

There is also a deeper philosophical perspective. When discussing this visualisation, the participant hoped to utilise it as the foundation from which to develop an emotional bond with the residents, which would lead to more fundamental changes to their attitudes towards the local environment.

5.6.3 Summary

This section has explored the way in which embodied processes emerge in the production and practice of data visualisations. These themes are explored more deeply in relation to post-representational literature. It has discussed the role of beauty and complexity in the unfolding practice of data visualisations. Whilst there is a value in the complexity and beauty of a visualisation, in a more corporate-driven environment or in fields such as data journalism, that value can be translated into an economic transaction. This appears to be founded on a more reputational basis – a reflection of how the user interprets the designer or authoring organisation – rather than the ability of the visualisation to communicate findings. This is highlighted in fields such as data journalism, where the visualisation is a projection of the designer's 'brand', at once showing findings and equally building a reputation, driving interest and securing further work (Cairo, 2015). In the local authority setting, there is a desire from the designers to challenge themselves, to act on inspiration within the field and to try to push boundaries (Cairo, 2016; Posavec and Lupi, 2016). This expands upon D'Ignazio's work and interprets complexity and beauty as not only a means of attracting and engaging audiences, but as a mechanism for engaging and attracting designers (see section 5.3.4).

However, this is at odds with the pragmatic, operational application of data visualisations. Therefore, the designers' instincts are reigned in. Notions of complexity and beauty can be considered as exclusionary mechanisms, the designing out of certain populations (see section 5.3.6). Therefore, the designers at the local authority case studies seek to orchestrate a more inclusive unfolding practice.

This section has also discussed the ways in which authorities tried to create an emotional bond with the user. This occurs through cultivating understanding, shared interest and collective identity. This emotional connection also increases through the presentation of the central government as the root cause. By differentiating themselves from the central government and aligning their needs with those of the public, the authority seeks to remove the accountability from the organisation. When considering this from a post-representational perspective, we recognise that the unfolding practice of data visualisation emerges through a myriad of entwined processes (see section 5.4.1). In these examples, the visualisation as an artefact does not seek to create an emotional bond with the user. Rather it is found in the narrative voice of the additional accompanying media and text (see social processes, 5.4.3). However, as discussed in the literature review in Chapter 2 (discussed further in section 2.3), the unfolding processes do not occur in isolation. They occur as a collaborative co-constitutive practice. The visualisation is constantly (re)made, as the user begins to absorb additional information which is then refolded back into emerging practice. By infusing the visualisation with the language of emotion, the authority seeks to somewhat alleviate the consequences of the tough, challenging reality by creating an emotional connection with the user (Aiello, 2006; Rupert, 2014).

Data visualisations are also mobilised by the authorities in trying to empower the local community – encouraging citizens to make positive changes by making them part of the solution and co-contributors (MacEachren, 2000; Peluso, 1995). The content of the visualisation seeks to unsettle, shock and provoke an emotional response from the user. As it unfolds, the user considers the possibilities of what this means to their local community and to other residents. The authority hopes the data will raise awareness of the seriousness of the issue and persuade the user to become more assertive and proactive in addressing these issues. The participant also gives an awareness of needing to strengthen the emotional bond between residents and authority (D'Ignazio, 2015). Making reference to 'working together' and 'local pride' shows that the authority is, to an extent, reliant on and places value in the contributions of the local community and the co-operation of local residents. Mobilising the emotive content of the visualisation cultivates a change in actions and perspective.

In answering these research questions, this thesis contributes to a methodological discourse in investigating data visualisation from a qualitative perspective. In keeping with the work of Couldry and Powell (2014), as previously highlighted, there has been a lack of attention in research to the social actors and groups of actors, in a variety of places and settings, which influence data visualisation production (see section, 4.4.10). Similarly, Ambrosio (2015) suggests that, in order to fully understand the production of data visualisations, we should consider them as a series of choices made by actors and intermediaries. More recently, Kennedy (2017) has suggested that the roles of actors and intermediaries are themselves influenced by the decisions and priorities of the organisations which

create them. This thesis therefore presents an initial attempt towards addressing these challenges by investigating the wide range of networks, actors and intermediaries within the context of a specific organisation. In addition, this thesis contributes more broadly to the field of post-representational cartography by providing an early attempt to answer Kitchin's (2007) call to untangle the unfolding practice of data visualisation. This is done by exploring the constellation of actors and their interactions that shape the unfolding, which includes knowledges (existing manuals and guides), practices (aesthetic choices, conventions), immaterialities (equipment, software) and the organisations themselves.

This research helps to address the lacuna in the theory of data visualisation by applying the post-representational approach, which seeks to build on, rather than replace, the growing literature on data visualisation, and does not exclude the bodies of work from the adjoining disciplines. Rather it presents a position, a point of focus, which encompasses the established work, and offers enough flexibility to encourage further development from fields not mentioned within this research. A post-representational approach recasts data visualisation as a broad set of practices, to think critically about the practices of visualisation and not simply to focus on the product. In doing so, it creates a theoretical space which incorporates both those seeking applied knowledge (asking technical questions) and those asking the theoretical questions. This research therefore presents a case for shifting the ontological position of data visualisations and considering them as processes, not as representations. This reveals that they are not practiced in isolation; they are mobilised in relation to other tasks and are subject to the complexities, interactions, constraints and emotions of that moment. Unpicking these conditions, as well as the aesthetic and technical elements of production, is key to providing a holistic interpretation of how data visualisations are actioned into being and made to do work in the world. By applying a post-representational cartography approach to data visualisations, to something more than mappings, this research also highlights the temporalities of engagement with maps and data visualisations. In everyday use, maps are enacted to solve relational problems such as how to get from A to B; they are usually actioned out of necessity (Del Casino and Hanna, 2000; Kitchin and Dodge, 2007). The map is enacted for as long as is needed in order to get to one's destination. Similarly, data visualisation is undertaken to provide insight or communicate analysis into a particular issue. In order to maximise interpretation, users must be receptive, curious about the subject and willing to invest time in interpreting its knowledge. A further difference is revealed when considering the difference in the temporality of 'becoming' for maps and data visualisations. The phenomena shown on maps do not change so readily: roads, mountains and cities are less likely to change in a drastic manner in the short term. However, local authority data visualisations are often designed for a specific time span – for instance, communicating results on a weekly, monthly or quarterly period. In the short term, the data changes, which often means illustrating an entirely new set of results.

This research has also adopted the work of Pickles (2004) and proposed that data visualisations should be considered not as readerly texts (those that create readers for an already written text), but as writerly ones (those which require the reader to, in part, author meaning). Interpreting data, visualisation in this way places recognition on the labour which is, in part, undertaken by the audience to gain insight, clarity and depth in interpretation. In applying Pickles' (2004) conceptualisation, data visualisations as writerly texts provide a multiple and open series of readings. This means that the success of a data visualisation in relaying its message is not an inevitable consequence of the design practice. The ability of the audience to interpret the information is not something which is rigid and can always be 'designed in'. It is a more fluid exchange between designer and audience, and the result of existing knowledge, skills and an audience's willingness to engage.

6: Conclusions

6.1 Introduction

The aim of this chapter is to draw together my findings, to outline the conclusions of this research and to identify avenues for future research. I will again repeat my research aims, which were outlined in Chapter 1.

1. *How and why do local authorities use data visualisation?*
2. *How do visualisations 'become'?*
3. *How useful is post-representational cartography to understanding data visualisation?*

Although this research focusses on local authority data visualisation, it does not present guidelines of best practice. Instead, it mobilises the context of local authorities to present an exploration of the processes through which data visualisations are (re)made.

I begin this chapter by reaffirming the context of this study and the need for a theoretical approach to data visualisation as identified through the literature review. In order to answer these questions, Chapter 2 addressed the relevant literature. The first section within Chapter 2 addressed the current surge in the amount of data which is now being produced and made available for investigation. This has led to a renewed faith in data (Kennedy, 2016) as a tool for decision-making. Gitelman and Jackson (2013) suggest that data should not be considered as objective, raw and coming from nowhere, but instead as the answer to specific questions given in a particular context. As such, data are not universal truths which can be mobilised to answer any given hypothesis. These assumptions of objectivity and the vast increase in the amounts of data have left problems in interpreting it. One proposed solution has come through visualisation. Section 2.3 examined work on how this mechanism acts as a tool for interpretation, analysis and decision-making. I explored the long history of data visualisation by addressing key examples from the past. Although this illustrated the historical use of data visualisation, it also highlighted the sparsity of theoretical work in the field, which lacks the depth of fields such as cartography. Data visualisation as a discipline is mainly approached from two key perspectives: first, that of the data visualisation practitioners who work within the conventions of design (e.g. Kennedy, 2017) and best practice. The second key approach is the scientific objective communication perspective (Few, 2004), which operates through a fixed ontology of scientific truth. Therefore, there has been little progress towards a critical, theoretical perspective of the field of data visualisation. To those key groups,

a data visualisation is never in a state of becoming; its ontology is fixed and it will always remain a data visualisation. Therefore, there has been little progress towards theoretical perspectives of data visualisation, something that is addressed within this research.

The literature review then explored subjects from which theoretical perspectives could be adopted and applied to data visualisation. It presented a chronological account of cartography, where attention was drawn to the multiple similarities to and overlapping theoretical developments with the field of data visualisation. Early work in cartography was focussed on models of communication (Morrison, 1976) and functionality (Robinson, 1976), which can be compared to the contemporary field of data visualisation. The critical turn in cartography began to deconstruct maps in order to reveal the hidden power dynamics. By deconstructing maps, scholars were able to build a new theoretical background of cartography, which placed each map in its own historical and social context and reflected the ideals of those who created it.

Most recently, scholars have sought to shift cartography from a representative to a processual approach, considering maps as ontogenetic, of the moment and brought into being and made to do work in the world (Kitchin, 2007). A post-representational cartography offers potential to provide a common framework both for those seeking applied knowledge (asking technical questions) and those who seek to ask ideological questions (Kitchin, 2012). Chapter 2 presented the gaps in the literatures of data and data visualisation and presented a chronological account of cartography in order to draw attention to the similarities between the two fields. It also illustrated cartography as a more mature discipline which has developed through theoretical and philosophical engagements which, to date, have been neglected from data visualisation.

Contemporary works within the field of data visualisation and the theoretical development within cartography are the sources of my research questions. This has allowed me to move beyond theoretical foundations and critiques of data visualisation as highlighted in Chapter 2 to the development of a mixed methods approach, which sought to investigate local authority data visualisation in England. This developed through two major stages of data collection. The first was through a broad scoping exercise utilising a survey questionnaire. From this, I gained an insight into local authority structural differences and pathways for producing data visualisation. This allowed me to construct criteria for case study selection. The chosen case studies were investigated in the second stage of data collection. The four selected cases were Authority 1, Authority 2, Authority 3 and Authority 4.

6.2 Summary of findings

In Chapter 4, I first presented the findings from the first key stage of data collection. The results of the survey into local authority data visualisation highlight the vast scope and variability in their size, structure and the services they deliver. Local authorities continue to be challenged by reduced budgets, reduced capacity to spend and reduced staff sizes. These economic challenges and the increase in availability of data have presented data visualisation as a partial solution to these issues, becoming a mechanism for data-based decision-making and streamlining analysis. There were three key pathways to the production of data visualisation identified from the survey results. The first two identified staff as being solely responsible for the initiation or application of data visualisation, or the organisations having no uniform data visualisation strategy. A smaller number of respondents highlighted their organisations as having access to a specialist designer or specialist design team. There were also three approaches to data collection: primary, open and ‘purchased as a subscription’.

Chapter 4 then explored the four selected case studies in depth, providing an account of their economic contexts, their responsibilities as service providers and their specific working practices in relation to data visualisation. The effects of austerity spending measures are not something which remains in the past; they are continuing, and Chapter 4 presented an in-depth look into the past and continuing effects of austerity on the selected four cases. These have provided operational challenges to some organisations in terms of their ability to engage with data visualisation. The case studies highlight the inventive networking and labour partnerships created by Authority 3 and the Yorkshire authority.

Building on the work of Chapter 4, Chapter 5 mobilised a framework adopted by Kitchin (2012) to investigate what can be understood from applying a post-representational cartographic approach to data visualisation. In understanding data visualisations post-representationally, it is recognised that the processes addressed by Kitchin (2012) – *aesthetic*, *technical*, *social*, *political* and *embodied* – do not exist in isolation. Rather they are playing out in competing, cohesive, multiple and simultaneous ways, exchanging and co-existing in various significant and temporal patterns. The *aesthetic* illustrates the role of the design conventions in presenting a professional standard for data visualisation creation. They provide the opening exchanges in the emergent practices of data visualisation – recognition that chart type and familiarity are the gateways through which the data visualisation begins to unfold. The *technical* skills and data literacy are key constraints to the unfolding practices of data visualisations. Within local authorities, complexity was reined in and limited to its most simple. Unlike maps, which can be used to solve relational problems, data visualisations are often enacted voluntarily (discussed further in section 5.3). Therefore, the length of time spent investing in the visualisation, interpreting

and absorbing its insight, can differ greatly between users. To maximise interpretation, users must be receptive to and curious about the subject, or be convinced to spend more time engaging in the unfolding practices by drawing the gaze of the user through beauty and complexity in design, or by striking an emotional response in the user. The *social* processes dimension of the framework illustrated data visualisation as unfolding through a collaborative function between user and narrator, through conversation and the actions of pointing, probing and tracing lines. The performance of a data visualisation begins to enable a more social, experiential unfolding, although the visualisation individually unfolds to each recipient. The narrator adds depth, clarity and understanding to the unfolding practice of the other user. Each social interaction and each answered question reframes the understanding and interpretation of visualisation.

Examining *political* processes illustrates the role of the designer in manipulating the message of the visualisation. In doing so, they become complicit in obscuring the complexity of a situation in favour of a more compelling ‘truth’, rooted in the interests of the organisation. Within local authorities, data visualisation creation is embedded within a tangled web of multiple competing and conflicting contexts, all being played out iteratively and interchangeably through the unfolding practice. The *embodied* framework explored notions of beauty, complexity and emotion in attracting engagement. In the local authority setting, there is a desire from the designers to challenge themselves, to act on inspiration within the field and to try to push boundaries. This expands upon D’Ignazio’s work and interprets the complexity and beauty as not only a means of attracting and engaging audiences, but as a mechanism for engaging and attracting designers. However, this is at odds with the pragmatic operational application of data visualisations. Therefore, their designs are simplified, as notions of complexity and beauty can be considered as exclusionary mechanisms and ‘designing out’ certain populations (see section 5.3.6). Therefore, the designers at the authority case studies seek to orchestrate a more inclusive unfolding practice, based on pragmatic and simple visualisations.

6.3 Contributions to academic discourse

The findings made in this thesis contribute to academic discourse in a series of ways. First, through the case studies presented in Chapter 4, this research extends the work of Kirk (2016) and his eight roles of data visualisation production. I argue that there is a further addition to this work and include the role of key field leaders, who were consistent in their influence of the designers and practitioners at each of the local authority case studies. This is significant, as they produce key handbooks and guidelines which then shape how visualisations are created, the insights they produce and the potential decision-making prompted by them. The field leaders are integral in shaping the debates in the subject. These actors

create new developments themselves, but also link new works and use their position to draw a much larger gaze upon developments they consider valuable. Therefore, this research proposes that they be considered as a further addition to the roles of production.

Second, this research contributes to methodological discourse, firstly in investigating data visualisation. By applying and then reflecting on the potential methods addressed by Kitchin (2012), this research sought to untangle the unfolding practice of data visualisation by exploring the constellation of actors and their interactions that shape the unfolding, as identified through the data visualisation literature (Ambrosio, 2015; Kennedy, 2017). Second, by providing an early attempt to answer Kitchin's (2007) call to untangle the unfolding practice of data visualisation by exploring the constellation of actors and their interactions that shape the unfolding. This includes knowledges (existing manuals and guides), practices (aesthetic choices, conventions), immaterialities (equipment, software) and the organisations themselves.

My third contribution relates to theoretical understandings of visualisations. As identified in Chapter 2, data visualisation lacks a cohesive field of academic study. This research therefore sought to offer a theoretical approach, which seeks to build upon, rather than replace, the growing literature on data visualisation. Nor does it exclude the bodies of work from the adjoining disciplines. Rather it presents a position, a point of focus, which encompasses the established work, and offers enough flexibility to encourage further development from fields not mentioned within this research. A post-representational approach recasts data visualisation as a broad set of practices, to think critically about the practices of cartography and not simply to focus on the product. In doing so, it creates a theoretical space which incorporates both those seeking applied knowledge (asking technical questions) and those seeking to challenge the ideological assumptions. As noted in Chapter 2, there is a consensus that data visualisations must be investigated in relation to their actors, intermediaries, contexts and the organisations in which they are created. This research therefore presents a case for shifting the ontological position of data visualisations and considering them as processes, not as representations. This presents an opportunity to view data visualisations as they are mobilised, more in tune with the day-to-day unfolding of everyday life. This reveals that they are not practiced in isolation; they are mobilised in relation to other tasks and are subject to the complexities, interactions, constraints and emotions of that moment. Unpicking these conditions, as well as the aesthetic and technical elements of production, is key to providing a holistic interpretation of how data visualisations are actioned into being and made to do work in the world. Interpreting post-representational cartography through something more than mappings provides us with a key difference in the temporality of engagement. As maps are usually enacted to solve relational problems, such as how to get from A to B, they are usually

actioned out of necessity. The map is enacted for as long as is needed in order to get to one's destination. In comparison, data visualisation often provides insight or communicates analysis into a particular issue. In order to maximise interpretation, users must be receptive, curious about the subject and willing to invest time in interpreting its knowledge. There is also a difference in the temporality of 'becoming' for maps and data visualisations. The phenomena on show in maps do not change so readily: roads, mountains and cities are less likely to change in a drastic manner over a period of months. However, local authority data visualisations are often the result of a specific timespan – for instance, communicating results on a weekly, monthly or quarterly period often means illustrating an entirely new set of results.

This research has also adopted the work of Pickles (2004) and proposes that data visualisations should be considered not as readerly texts (those that create readers for an already written text, but as writerly ones (those which require the reader to, in part, author meaning). Interpreting data visualisation in this way places recognition on the labour which is, in part, undertaken by the audience to gain insight, clarity and depth in interpretation. In applying Pickles' (2004) conceptualisation, data visualisations as writerly texts provide a multiple and open series of readings. This means that the success of a data visualisation in relaying its message is not an inevitable consequence of the design practice. The ability of the audience to interpret the information is not something which is rigid and can always be 'designed in'. It is a more fluid exchange between designer and audience, and the result of existing knowledge, skills and an audience's willingness to engage.

6.4 Potential future research agendas

This research has focussed on the application of a post-representational cartography framework to help understand the practice of local authority data visualisation. In terms of future research, I see three potential areas of interest. First, in direct relation to this study, a longitudinal study would track the development of local authority data visualisation and provide an account of whether innovation continues to evolve. As proposed in this study, local authorities are relatively immature in terms of their engagement with data visualisation and the participants from within the organisations consider this to be the beginning of a journey. Therefore, a longer time span would trace the practices of data visualisation as they grow and mature. As noted throughout Chapter 4, the austerity spending measures which have contextualised this research are proposed to continue in the coming years. A longer study would provide insight into whether more local authority organisations in England will turn to data visualisation, as is suggested in this work.

The second avenue of interest would again be in direct relation to this research. Due to time constraints, it was decided to focus primarily on the internal communications of local authority data visualisation. Therefore, a further avenue of research would include a study into local authority data visualisation as unfolding in the public sphere – that is, data visualisations which are mobilised for public communication and engagement. This would explore how local authority residents understand and remake data visualisations, and whether they are a result of the same processes as they emerge. It would also provide further insight into issues of data literacy within the public population, something that was addressed from the local authority perspective within this study.

The final area for future research is to explore the unfolding of data visualisation from a slightly different aspect of the field. I would propose an investigation of data journalism from a post-representational perspective. As suggested in section 5.6, there is more freedom within these fields to explore the value of beauty and art in attraction and engagement. A post-representational framework would allow for an investigation into how these factors are considered in production, as well as their effects on audiences. This could offer valuable insight into different working constraints, actors and intermediaries, as well as producing primarily for digital media rather than paper documents. This is an important aspect of data visualisation which has so far been neglected.

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Appendices

Appendix A: Overview of case study authorities

Authority 1

Structure

City development

In broad terms, the city development department is responsible for the physical, economic and cultural development of the city. It covers a broad range of issues including regeneration work, support to business, jobs, and skills. They are also responsible for sites of culture and heritage, which include, museums, galleries, stately homes, leisure centers, markets and planning and highways.

Communities and environment

Responsible for the delivery of locality services and for most of the Council's front line community services, including: the one stop centers, libraries, community hubs and the contact center; bins and other refuse services, street cleaning, environmental enforcement, recycling, environmental health including noise nuisance and pest control, the city's parks and areas of countryside, community safety, anti-social behavior and parking services including carpark management and parking enforcement.

Resources and housing

Responsible for human resources, shared services, finance and business rates, ICT and digital information, catering, cleaning, legal and democratic services, projects and procurement. Along with housing services, homelessness and sustainability. Also responsible for the council's strategic policy and communications team

Children and families

These services include: school admissions, support to schools and governors, school improvement, support to vulnerable learners, early help and children's centers, Children's Social Work Services including fostering, adoption and children's homes, services to support children with learning difficulties and disabilities and a range of specialist services for children and young people including Family Group Conferencing, Youth Offending Services and Multi Systemic Therapy.

Adults and health

This department is responsible for all adult social care services requiring the assessment for, and arrangement of, services to meet the personal social care needs of those who may be physically or learning disabled, have mental health needs or may be frail through old age. This includes provision of information, social work, safeguarding, support to voluntary and independent providers of care and direct management of a range of home care, day time support and residential services.

List of services

- Education
- Highways
- Transport planning
- Passenger transport
- Social care
- Housing
- Libraries
- Leisure and recreation
- Environmental health
- Waste collection and disposal
- Planning applications
- Strategic planning and local taxation collection.

Spending on services

A breakdown of sources of funding can be found below:

Table 4.1: Authority 1: sources of funding (2017/2018)

Revenue – General Fund	£000s
Council tax	265,126
Business rates	136,204
Revenue support grant	93,048
	496,378
Specific funding	£000s
Specific government grants	933,300
Fees, charges and interest	267,230
Rents	229,275
Use of reserves	74212
	1,504,017
Total	2,000,395

Table 4.2 Authority 1 budget distribution 2017/2018

2016/17 budget	Net £M	% of net budget
Adult social care	201.3	40.55
Children's services	120.5	24.27
City development	43.0	8.66
Environment and housing	53.9	10.86
Strategy and resources	35.4	7.13

Citizens and communities	24.6	4.96
Civic enterprise	24.4	4.71
Public health	0.3	0.06
Strategic and central accounts	2.6	0.5
Contributions to (from general reserve)	3.4	0.7
Net revenue budget	496.4	100

Authority 2

Structure

Communities, health and social care

This department is responsible for a range of community services such as, community cohesion and equalities, community links, community cohesion and equalities. They contribute to wellbeing projects such as the drug and alcohol action team. They also cover a range of locality services such as libraries and emergency, planning safer communities, trading standards and drugs and alcohol services.

Adults, family and wellbeing

This department covers a wide range of services including adult learning. There is a safeguarding team who work with physical sensory and learning disability. As well as an older peoples service who focus on work such as registrars and coroners, commissioning.

Children's social care and learning

The children's social care and learning work on a wide range of children's education and safeguarding issues such as: Assessment and protection, early help and intervention and youth offending services. The learning teams focus on issues such as quality standards and performance and school academy relationships

Transport, Economy and Environment

The transport side of this department focuses on a wide range of issues such as highways, traffic, and public transport services. Whilst environmental services focus on operational and regulatory waste and more general environmental concerns.

Resources

The resources team focus on financial, property, payroll and corporate business support,

This department also houses the human resources team and the IT team.

Chief executive's services

This department crucially focuses on business intelligence and insight that aims to drive business improvement. There is also a communications department who focus on issues such as civic and events, complaints and strategy. Finally, there is the legal advice team.

Services

- Education,
- Social services
- Libraries
- Main roads
- Public transport
- Policing and fire services
- Trading standards
- Waste disposal
- Strategic planning.

Table 4.3, Authority 2 savings generated 2017/18

Savings	16/17 £M	2019/2020 (£m)
Efficiencies	22.74	40.27
Increased income	2.83	7.37
Service reduction	1.75	4.98

Other streams of income outside the usual government revenue support grant play an important role in financing service delivery at this authority. A breakdown of alternative income streams can be found below.

Sources of Income

Table 4.4 , Authority 2 income sources, annual report, 2017

	2017/18 £M
Revenue support grant	8.1
Top Up	25.9
Education services grant	5.0
New homes bonus	3.6
Transition grant	4.6
Other	4.4

Table 4.5, Authority 2 sources of funding 2017

Use of reserves	-403
Revenue support grant	-8,078
Top up grant	-25,822
Transitional grant	-4586

Locally retained business rates	-18, 048
Education services grant	-1,627
New homes bonus grant	- 3,119
Other grants	-3,707
Council tax, surplus on collection	-3,517
Total financing	-68,907
Council tax requirement	261, 436

Spending on services

Figure 4.6 Authority 2 spending on services, 2017/18

Department	Percentage of £330 (excluding schools)
Adults social care, health and well being	38%
Children's social care and safeguarding	18%
Environment, waste disposal and country parks	3%
Roads and Transport	8%
Other corporate costs	14%
Libraries and communities	3%
Education and skills for young people and adults	9%
Property, commercial, legal and finance	7%

Table 4.3, Authority 2 savings generated 2017/18

Savings	16/17 £M	2019/2020 (£m)
Efficiencies	22.74	40.27
Increased income	2.83	7.37
Service reduction	1.75	4.98

Authority 3

Services

- Education
- Housing
- Planning applications
- Strategic planning
- Transport planning
- Passenger transport
- Highways
- Social services
- Libraries
- Leisure and recreation
- Waste collection
- Waste disposal
- Environmental health
- Revenue collection

Structure

Places A: environment, planning and transport

Responsibilities include, planning support, land charges, community safety, environmental management, waste, transport, public rights of way, road safety, transport strategy, highways, parking services and traffic.

Places B: Development and economy

Responsibilities include registrars, births and deaths, libraries and heritage, culture, school sports, housing strategy, community infrastructure, digital management, plan policy and housing, tourism and property services.

People A: Adults services

Adult social care, community services, prevention and safeguarding, commissioning, procurement and contracts, health and social care. Business and intelligence.

People B: Adult learning and children services

Safeguarding, service improvements, child social care. Early support targeted interventions. Education skills and learning.

Resources

Finances, revenue and benefits manager, corporate projects, corporate performance, legal, human resources, electoral services, IT and customer service

Spending on services

Figure 4.7. Authority 3 budget 2018/2019 broken down by directorate

	Budget 2018/2019 £000
People	18, 136
Places	12, 033
Resources	5906
Total	36, 075

Figure 4.8, Authority 3, total costs of services

	2018/19	2019/20	2020/21

People	12, 033, 100	12,083,600	12,361,200
Places	18,135,900	17,811,800	18,118,700
Resources	5,906,400	6,030,900	6,112,400
Pay continuity	384,400	777,700	1,007,100
Social care continuity	100,000	100,000	100,00
Total	36,559,100	36,683,000	39,666,500

Authority 4

Structure

People

This department offers services in the following areas:

Adult and children's social care, protection, commissioning, learning services, school places, early years support, school improvement, fostering and adoption services, vulnerable children, corporate parenting and residential services.

Place

This department offers services in the following areas:

City renewal services, economic prosperity, city regeneration and development. Housing and planning, homelessness. Also responsible for sites of culture and heritage, leisure centers.

Customer Services

This department offers services in the following areas:

Business and technology, policy and city engagement, customer services, digital information, shared services.

Operations

This department offers services in the following areas:

Human resources, transformation, commercial finance, monitoring, legal and democratic services

Public Health

This department offers services in the following areas:

Responsible for the promotion of health and wellbeing across the region. Covering services such as prevention of infection, immunization and public health protection.

Services

- Education
- Housing
- Planning applications
- Strategic planning
- Transport planning
- Passenger transport
- Highways
- Social services
- Libraries
- Leisure and recreation
- Waste collection
- Waste disposal
- Environmental health
- Revenue collection

Spending on service

Table 4.9 : Authority 4 budget per service area 2018

Service area	Budget 17/18 £m
Children's and family services	51.2
Public health and adult social care	73.1
Place, growth and prosperity	35.2
Housing and customer services	13.3
City director and corporate services	14.8
Financing and non-departmental costs	20.7
Total	208.3

Table 4.10: Authority 4 breakdown of the funding sources

Funding	Budget 2017/18 £M
Revenue support grant	37.8
Retained non domestic rates (business rates)	43.7
Top up grant (business rates)	28.5
Collection fund (surplus)/ deficit	5.7
Ring-fenced grants	1.4
Non ring-fenced grants	5.0
Contribution from reserves	3.3
Capital reserves	7.3
	132.7
Council Tax Requirement	75.6

Appendix B: Survey information and questionnaire

Survey

Local Authority Visualisation Survey

Page 1: Section 1. Introduction



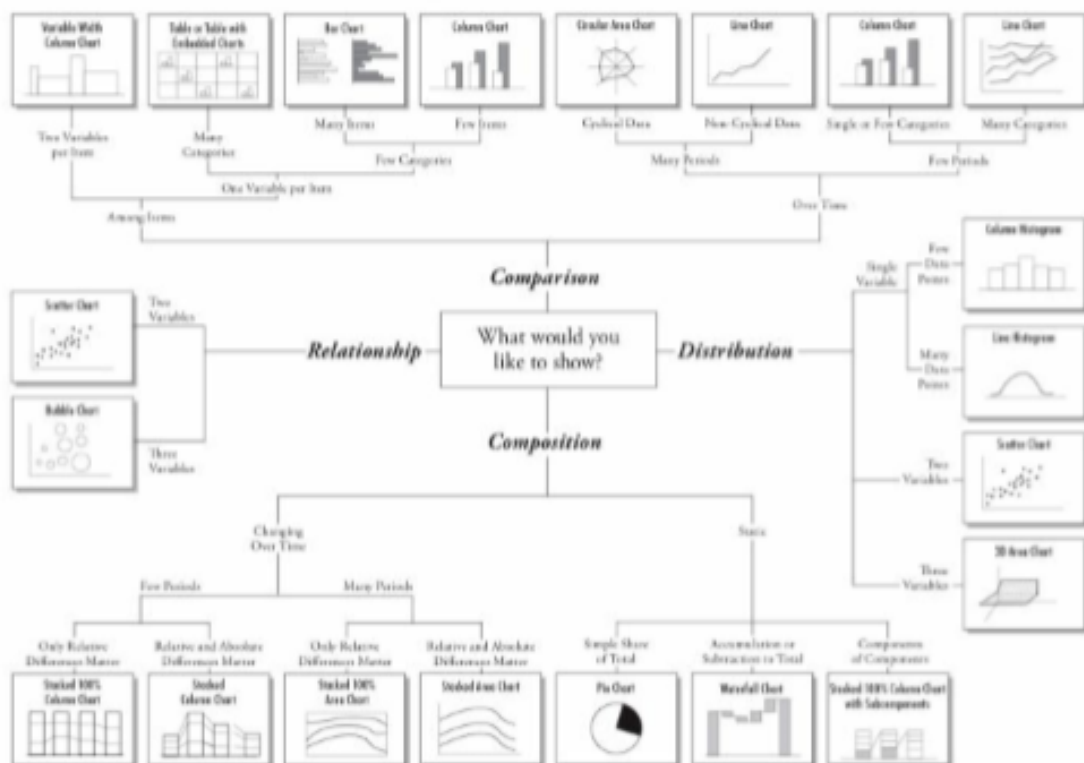
About

My name is Adam Jenson I am a PHD student at Northumbria University. I am doing research on how data visualisation techniques are used by local authorities.

Data visualisation is the general term that describes any effort to present data in a pictorial or graphic format. Data visualisations can include a wide range of graphs, infographics and maps with varying degrees of complexity. They are often utilised as a means of exploring data to identify trends and patterns or to communicate those findings to wider audience.

Below is a graphic which helps illustrate the varying ways data can be visualised. Although not exhaustive, it does provide a good introduction to data visualisation (Abela, 2006)

Chart Suggestions—A Thought-Starter



My research aims to analyse:

- Theories of data visualisation
- How and why local authorities use visualisations
- The factors which influence their production and consumption

This is the first phase of research and aims to identify differences and trends which may exist on a national scale.

What follows are 19 questions about your skills and your work with visualisations.

Ethics

All academic research is done within an ethical framework designed to protect participants. Approval has been granted by my faculty's ethics committee to undertake this research, and these are the measures in place to protect you and your data:

- all questions are optional
- all data relating to a specific local authority or person will be made anonymous at the

request of the participants

- aggregated statistics may be published online and in academic journals. This will consist of general findings and individuals won't be identifiable
- you have the right to withdraw your data at any point
- raw data will be destroyed two years after the end of the project. My funding runs from Oct 2014 until Oct 2017

If you're happy with this please continue to the survey.

Contact

Email: Adam.jenson@northumbria.ac.uk

Twitter: @adamjenson88

Supervisor

Jon.swords@northumbria.ac.uk

Page 2: About your visualisations

1 Why does your local authority use data visualisations? *Please tick all that apply*

- ☐ Support decision making
- ☐ Monitor performance
- ☐ Improve service delivery
- ☐ Promote transparency
- ☐ Utilise open data
- ☐ Promote accountability
- ☐ Community engagement
- ☐ Explore data
- ☐ Identify patterns and trends in data
- ☐ Communicate data to others
- ☐ Other

1.a If you selected Other, please specify:

2 Which of the following types of data visualisations have you used? *Please tick all that apply* For more information and examples please follow the link provided below:
<http://www.improving-visualisation.org/tags>

- ☐ Bar chart
- ☐ Table
- ☐ Map
- ☐ Pictorial
- ☐ Pie chart
- ☐ Bubble chart
- ☐ Choropleth map
- ☐ Doughnut chart
- ☐ Animation
- ☐ Qualitative
- ☐ Box plot

- ☐ Dashboard
- ☐ Venn diagram
- ☐ Gantt chart
- ☐ Traffic light
- ☐ Timeline
- ☐ Line Chart
- ☐ Population pyramid
- ☐ Dot Plot
- ☐ Interactive
- ☐ Statistical map
- ☐ Histogram
- ☐ Scatterplot
- ☐ Tree map
- ☐ Other

2.a If you selected Other, please specify: *Optional*

3 What computer software is used to create visualisations?

4 When using visualisations, which areas have they contributed to?

- ☐ Access to services
- ☐ Communities
- ☐ Crime
- ☐ Demography
- ☐ Deprivation
- ☐ Education
- ☐ Employment
- ☐ Environment

- ☐ Health and Wellbeing
- ☐ Housing
- ☐ Transparency
- ☐ Neighbourhoods
- ☐ Open data
- ☐ Sustainable Communities Strategies
- ☐ Local Area Arrangements
- ☐ Joint Strategic Needs Assessment
- ☐ Other

4.a If you selected Other, please specify

5 Where do you source your information or data from?

- ☐ My local authority
- ☐ Other local authorities
- ☐ Office for National Statistics
- ☐ Communities and Local Government
- ☐ European Union
- ☐ United Nations
- ☐ Consultants
- ☐ Academics
- ☐ Ordnance Survey
- ☐ Other

5.a If you selected Other, please specify:

6 In which of the following formats have visualisations been used?

- ☐ Report
- ☐ Written Document
- ☐ Presentation
- ☐ Web Page
- ☐ Dashboard
- ☐ Mobile Application
- ☐ Interactive Web Tool
- ☐ Paper Document
- ☐ Other

6.a If you selected Other, please specify:

7 In total, how many documents have visualisations contributed to?

- ☐ None
- ☐ 1-4
- ☐ 5-19
- ☐ 20-34
- ☐ more than 35

8 When publishing visualisations, who is your target audience(s)? *Please select all that apply:*

- ☐ Staff of this local authority
- ☐ Staff of other local authorities
- ☐ Partner organisations e.g. local health organisations
- ☐ Local business
- ☐ Businesses from outside the area
- ☐ Community groups
- ☐ Public
- ☐ Media

☐ Other

8.a If you selected Other, please specify:

9 Who creates the data visualisations for your local authority? Please select the statement that is most applicable to your local authority:

- ☐ We have a specialist
- ☐ We have a designated team
- ☐ Each department has a specialist
- ☐ Each department has their own approach
- ☐ Staff create their own data visualisations
- ☐ There is no uniformed approach
- ☐ They are produced elsewhere

9.a Could you specify the organisation they work for? *Optional*

10 When working with visualisations has your local authority ever outsourced work?

- ☐ Yes
- ☐ No

10.a If you selected Yes, please specify the name of the organisation(s): *Optional*

11 When using visualisation have you worked with any major partner organisations in authoring data visualisations?

- ☐ Yes
- ☐ No

11.a If you selected Yes, please specify the name of those organisations:

11.b What was the role of the major partner organisation?

- ☐ Data collection
- ☐ Data management
- ☐ Visualisation creation
- ☐ Publishing visualisations
- ☐ Other

11.b.i If you selected Other, please specify:

11.c How frequently have you worked with major partner organisations?

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often
- ☐ Always

Page 3: Skills and Experience

12 Have you recieved any formal training regarding visualisations?

- ☐ Yes
- ☐ No

If you answered No, please continue to the final question

13 How was training provided?

- ☐ Internal
- ☐ External
- ☐ Both

13.a If you selected internal, could you please specify who provided training: *Optional*

13.b If you selected External, please specify the name of the organisation who provided the training *Optional*

13.c Please specify the name of the department or organisations who provided training:
Optional

14 Was this at a cost to your local authority?

- ☐ Yes
- ☐ No

Page 4: Section 2. About you and your local authority

The following section is optional

15 Which local authority do you work for? *Answers given in this section will be treated in confidence*

16 What department do you work in? *Answers in this section will be treated in confidence*

17 What is your job title? *Answers in this section will be treated in confidence*

18 How long have you worked at this Local Authority? *Answers in this section will be treated in confidence*

- ☐ less than 6 months
- ☐ Less than a year
- ☐ 1-3 years
- ☐ 4-10 years
- ☐ more than 10 years

19 Is there anything else you would like to add?

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Page 5: That's it

Finished

Thank you for taking the time to complete this survey. If you have anything to add that was not covered in the questions you can email me:

adam.jenson@northumbria.ac.uk

Further involvement

The final stage of my research is to interview people involved in the processes of visualisation production. If you are willing to participate in a follow up interview please follow the link provided and enter your details in the contact form

<https://adamjenson.wordpress.com/contact/>

Appendix C: Example of Interview Transcript

A: Can you give me a bit of background and about yourself

Participant: I am an economist by training and I have a phd in economics. I spent the first few years of my career at New York City at a non-profit and spent the next nearly ten years at the congressional budget office in Washington dc and for the last few years I've been at the urban institute which is a non-profit institution, also in DC. Um so I, as I said I am an economist so my background is in conducting research, its mostly in areas of nutrition, economic programs and disability um immigration and some other things, but about ummm I don't know three four five years ago maybe I started to become very interested in this area of data visualization and communicating data. I developed some expertise in doing that and creating some visualizations and critiquing visualizations as they relate to public policy and economics and um I then expanded or pivoted a little bit and worked a little more in the areas of presentation design and delivery and so erm now I spend a good chunk of my day helping others here at urban and elsewhere do a better job of communicating data and communicating their analysis. Usually for folks who are working on data on a regular basis and are conducting economic and public policy research.

A: Would you consider working in the field of data visualization your full time job?

Participant: well I still do conduct research at my full time job at urban half my time is where I do the data viz and other work and half my time is research and that right now is primarily working on disability and insurance programs and then I have my consulting firm on the side, and that's all data visualization and data analytics that sort of thing.

The other side of my life is the consulting firm which tends to be a lot of training and consulting on data analytics and data workflow issues but there is some overlap between what I do at both.

A: Who do you consult for?

Participant: Most of my clients tend to be data analytics firms and government agencies. Places that are working with a lot of data, publishing a lot of reports. They are either doing it as objective research or they are doing it as some goal or some mission in mind. Most of my clients tend to be folks doing research. I wouldn't say big data but not a ton of people who are doing international work and I only have a couple of clients doing qualitative work. So it's a lot of people working with data and trying to communicate data in that sort of way.

A: What skills are most needed and most in demand in government agencies?

Participant: So uh the folks that I work with tend to be economists, political scientists, mathematicians, statisticians um they are good at finding data, working with the data, processing it and analysing it. But not so much on the communication side so that's where I sort of come in. The, um places I work with don't have a large communications department, if they do its always very different from the folks that are doing the analysis so folks are kind of silod off from one another. So when you go through for economists for example, like me when I went through graduate school I didn't learn anything about communication, skills and writing or giving presentations things like that, so it's really a new skill for a lot of these people. So they've typically thought of I have some sort of research question, some sort of hypothesis and I'm gonna go dig into the data and try and answer that question but they typically haven't thought about the next step of how I'm gonna communicate this to a particular audience may be for this particular project.

It's not to be expected if you step back from it for a while. We are in a moment of time if you will. where data has become uh it's become more valuable its sort of the currency people are dealing in, so if we step back and say why is random agency doing a better job of communicating there work when other places aren't. Well they have a staff whose job it has been for a long time to collect all this data and maybe there job hasn't been to process or publish it they've been collecting it because that's the rule and now there being asked to do other things which are not in their dna to think that way as a researcher. It's a real mind shift for individuals, then it becomes a culture shift for an organisation which is not easy to do.

A: your website says you work with policy relevant data products could you explain?

Participant: So erm so as I said the research I've done is all public policy, disability, immigration and the people I work with at cpo certainly we were creating report after report after report and it seemed no one was reading it, so we tried to do some visualization type slides. we did infographics, this was my first foray into this field then we did some other smaller graph types and started introducing different report types to try and change the way we were showing that so all those visualizations. So everything we were producing there was for public policy, was to provide information to members of congress. So erm everything being produced there was policy relevant. So here at urban, urban is non-profit and again were working in the public policy area. We have a group that does health, a group that does justice, a group that does housing policy erm we have 9 or 10 different researchers doing different typed of public policy or economic research. And so all of the visualizations others create or I sometimes help

create or I create on my own. Well never really on my own it's always in a team. The visualizations we create as an organisation are all linked to public policy, are all elevated to the debate around public policy, to bring facts and data to that discussion. The visualizations are there to support that analysis and to communicate that analysis in better ways.

A: Can I ask about your workshops?

Participant: Basically I worked at cbo for a while, got interested in data viz, had some early successes creating things that people at cbo and congress were able to use and were able to find insight in, that they may or not have gotten in the 140 page report. With that then I started to think about how I could change my own approach to research and communication and I was working with co-workers and colleagues there. So basically since that time it's become my mission to help people improve how they communicate their research. So what the workshops do is, try to give people an introductory, I call it core principles of/ to data visualization and to presenting to an audience and some tools. The goal is really to get people thinking about how to better present their research. Lots of researchers like well I'm gonna add a line chart to this report and they haven't really thought about why. It what you might call a slide show effect. Its papery, you write a paper it says figure one shows this figure 2 shows this and you put in the figures cos they have to be there whereas they may not be adding a lot of value, specific value to the audience. So my goal in the workshops is to help people improve how they communicate their work. As I said a lot of the folks I work with are data analyst's data analytics folks primarily doing public policy. It's a core sort of group that i work with. So it's all folks doing data work and trying to communicate that in better ways.

A: What are the most Common barriers before workshops?

Participant: I think the big thing is that they haven't really thought they haven't thought carefully about how to communicate their work. They haven't thought about their audience, there very good at working with the data, they understand the data, they understand the question they wanna ask, the question they wanna answer with the data, they understand how to create a model and how to bring data to answer that question, but they haven't thought about the next or perhaps one of the most important things which is who is the audience and how do I get them to agree or how to buy into this statement so they haven't actually thought about. So that's why an introductory course that I run is primarily concerned with getting people to think broadly about data and communication and ways they can expand their own graphic literacy and those of the audience and to get them to think more carefully about the audience,

and to think about the output more carefully and to share with them the reader or user or whatever the output is going to be.

A: Can I ask about the critical feedback web forum?

Participant: That peiecee by veigas and wattenberg is a great piece and it makes a number of great points, one of them. The most important being that the critic needs to be, I think that the critic needs to be respectful and understand what the designer is supposed to do. It sort of had a similar feeling to the paper in that the critique, the data viz field can be a bit snarky sometimes and so what you'd find sometimes is critiques on twitter , on social media that were like oooh this graph is terrible. Ah you know, this graph isn't so good. And you know I'm as guilty of it as anybody but erm so what I wanted to do was create a place where people could solicit advice and solicit feedback and have a conversation about viz that they liked or didn't like but really more sort of focussed on the design process and the creation process. And I'd say you know it is in some ways a social media platform. In the sense that it only sort of works, when people submit things to the site. That's where the difficulty is as it were. To get people to put things up. People were reluctant to sort of offer themselves up for criticism when there designing or maybe they have internal data that they can't really share. The goal of the. The purpose of the site was to allow the community to weigh in, in a more constructive and thoughtful and longer way. So that you could see a viz that someone has created, you could get the data, you could create something and you could post your viz in a longer comment thread about why you thought this was a better version than the original. What you did. How you did it. So it didn't have to be 140 characters. It wasn't in the comment box at the bottom of the page somewhere. It ebbs and flows because it does require the community to sort of contribute and act on it to actually work.

Over the last few months I haven't really been putting as much time into it. I've been working and trying to finish my book on presentation. So that's coming to a close and I'm working on a website redesign. And so then I'll be able to put a bit more time back into it. I've had a lot of ideas on how to expand it. Maybe it's not just people soliciting feedback and comments but maybe let's put a visualization that people are talking about on twitter and let's have it on the site and have more of a longer conversation about it on the site. So there's a lot of ways in which the project could go. But I haven't put enough, at least in the last four months or so, put as much time into it as probably i can or should have.

A What's your usual production line or production pathway when creating visualizations?

Participant: At urban the way things work is more or less a researcher has a project, and there's lots of projects they can have. They might have a brief which can be 5 pages, they might have a report which could be 30-40 pages or hundreds of pages, they might wanna do a blog post, they might wanna do a series of blog posts, they might wanna do a full interactive feature of visualization there's lots of product types we have. So let's talk generically about a product. So the researcher is conducting the research. First they have an idea about the output that they want to have. So the first step here for them is to fill out the internal web platform they fill out what we call an intake for that asks them some questions about what's the question you're trying to answer, what's the audience. Who are the main audiences or decision makers, or policy makers or whoever that you're targeting. What's your level of interest in actually contributing to helping to finish the visualization? All that good stuff. The whole communication staff has a meeting. We meet every week with these various intake forms and we sort out the team for each of the project. So some projects will just have a social media manager, some projects may just have a designer or editor. Or it may have the full team's attention depending on the project, so we have an events team we have a developers, we have political outreach folks. We have different teams and we sort of set that in motion. The researcher does the research, we have ideas for the project, we set up a project plan which will basically be sitting down with the various teams and the research team setting out a work plan and going from there. And then you get somewhere, it depends. Obviously an interactive visualisation will require more work with our developer team. A one off statograph may be fairly simple that we have a designer step in and finish it, or sometimes we've changed some of the process for the researchers where they can just use excel and they will be able to create most of their visualizations quickly in excel. It depends, but I will say that it's a team effort and it goes through a specific process that we walk through. Bringing all those different teams together.

A What are the biggest or most common constraints of working in these ways?

Participant: I stretch between the two the communications side and the research side. So the researchers people always complain to me that the communications people don't understand the data, they don't understand the research, they don't understand the story. And the communications people that the researchers don't understand the importance of design, they don't understand how long it takes to make these sorts of things. There are challenges on both sides of the equation. On the one side the researchers need to understand that the design and development process is not simple and it's not the sort of thing where you say i want to have this thing done by the end of the day can you just do it. It's a skill and it takes time and a lot of effort to pull these projects together. Then the designers, to respect and understand the data is the most important thing. That the data is the bedrock of a data visualization otherwise your just making pictures. We're trying to bring those groups together but I think that's erm

that is part of the big challenges, is getting those groups to communicate in better ways. That's one of the biggest challenges. There's lots of other challenges with technology and project management that sort of thing. But just on the personal side its getting the two groups to come together and make sure they understand that there's no one skill set or one process or skill set that will make these things. You do need a team. You need people who have different skills and different expertise to bring them all together.

A Can I ask about your data viz podcast?

Participant: It's been going a little over a year. 56th episode next week. I call the podcast layman's blogging. Because I get to just talk to really smart cool people for 20-25 minutes and ask them about their work and what they're doing and the ways they communicate data. It's still a one man show at the moment. So I have a whole schedule I record the episodes, I have someone that helps me with the voiceover for the sponsor message I have one. I have someone who mixes the sound. The whole goal again is to get some of those voices out there of people who are working with data. People who are creating visualizations and presentations and also some open data stuff that I focus on and what I also, starting in the fall I also have more researchers on the show. People who are actually getting their hands really dirty with the data and finding challenges with data and how there struggling with research questions and all that good stuff. It's been a lot of fun. I really enjoy doing it. I find it easier than writing blog posts that can take a while and a few hours to edit. I've already got a few recorded for the fall but I'm looking forward to talking to some more fun people. I've tried to mix and match the big names in the field with the people who are on the ground doing everyday work. I've had Edward Tufte on the show, I've had Nigel Holmes on the show who are like the standard bearers of data viz. I've also had people who are on the ground working with data. Rob Simmons, who's at planet labs doing colour and mapping. I've had Justin grimes who's here in DC doing open data work but I've also had some of the data journalists. Most of the people I would call friends of mine, I'm also trying to find people who are doing interesting work that's current. You see some people in the fall, you know there are some people who are famous within the field. And some people whose names you might not have heard. There's the Alberto Cairo and the Andy Kirks of the world, who everyone knows and then there are other people doing great work whose names just aren't as out there. For whatever reason, for good or for bad. There's just so many people out there doing great stuff, from so many different fields. I'll be talking to someone in November who is doing machine learning and artificial intelligence. Or someone from the industrial organisation psychology field. So there's data viz that is everywhere, everywhere people are working with data you see it. So it's really fun to talk to people from different fields and see how their using it. I try to approach it from a broad brush

A: Thank you for taking the time to interview today, its really appreciated

Participant: Anytime